THE THERMODYNAMIC PROPERTIES OF AMMONIA

COMPUTED FOR THE USE OF ENGINEERS FROM NEW EXPERIMENTAL DATA DERIVED FROM INVESTIGATIONS MADE AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BY

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PREFACE

These tables of the properties of saturated and superheated ammonia are based for the most part on an experimental investigation carried out during the course of several years in the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. This investigation was suggested by Professor Edward F. Miller of the Institute's Mechanical Engineering Department, which generously supplied many of the facilities needed in prosecuting the experimental investigation.

The original intention was to determine the vapor-pressure curve and the specific heat-capacity of liquid ammonia with the view of utilizing the results obtained as a partial basis for the computation of a new table of the thermodynamic properties of ammonia which would prove useful in controlling the performance of refrigerating machines. After the completion of the preliminary work, in connection with which the already existing data had been critically examined, it appeared desirable to carry out a more comprehensive experimental investigation. Throughout the whole work we have been indebted to Professor Miller for his advice and support.

The experimental work was carried out by Henry A. Babcock, Harvey S. Benson and Robert B. Brownlee, senior and graduate students in the Mechanical Engineering Department, under the direction of Frederick G. Keyes, a member of the Research Laboratory staff. Mr. Babcock took up the portion of the work bearing on the heat-capacity of liquid ammonia. Messrs. Benson and Brownlee began the determination of the vapor-pressures, the liquid specific volumes, and the isotherms of the substance and continued this work during the following year. Mr. Brownlee collaborated with Mr. Keyes in working over all the data and in constructing the necessary diagrams for the tables.

The computation of the tables was carried out by George W. Clark, Instructor in the Mechanical Engineering Department of the Institute. Mr. Clark's task was especially difficult because of the form of the equation of state employed; and it was carried out by him with great skill and intelligence. This part of the work was aided financially by a generous grant from the Rumford Fund of the American Academy. The computed values have been thoroughly and independently checked by F. G. Keyes.

The experimental methods employed and the details of the data obtained will, it is hoped, soon be ready for publication. It was decided, however, to print the tables in advance of the publication of the experimental research on account of the technical need of more accurate tables than have been hitherto accessible.

The treatment of the experimental results obtained and the critical study of other observers' data have resulted in some new methods of examining experimental data which are here presented in considerable detail, for it is hoped that they will be of service to others interested in similar studies. The form of the equation of state employed is very different from those which have hitherto been employed in computing tables. The usual equations employed give the volume explicitly, while the equation used in computing the present tables possesses five values of the volume. The multiple value of the volume is an obvious physical necessity from the point of view of the continuity of the phases; and a careful study of the application of the equation, not only to the vapor phase of ammonia but also to the existing data for several other substances, has shown its use to be justified. The use of the equation for practical purposes has moreover led to the development of special methods of application which greatly lighten the labor involved in computing.

The tables have been brought into the usual forms convenient for engineering practice. In addition to the tables an accurate "Mollier" diagram has been prepared which has proved to be of very material assistance for rapidly solving engineering problems.

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PART I

DISCUSSION OF THE DATA AND COMPUTATIONS

LIST OF SYMBOLS USED

dQ: Element of heat absorbed when the work dW is represented by $p\,dv$.
dH: Element of heat absorbed when the work dW is represented by $d\,(pv)$.
dU: Increment of the internal energy.
1 : Subscript referring to the vapor phase.
2 . Subscript referring to the liquid phase.
s : Subscript referring to the saturation state.
p : Pressure (or force per unit area).
v : Volume of a unit of weight.
T : Temperature reckoned on the absolute scale or on the (substantially equivalent) hydrogen scale.
C : Specific heat where the heat element dQ is considered.
γ : Specific heat where the heat element dH is considered.
Φ : Entropy defined as $\int \frac{dQ}{T}$.
L : Heat of evaporation of unit-weight of a substance.
R : Absolute gas constant defined by $pv = RT$.
δ : Correction term of the volume in the equation of state.
a and l : Constants of the cohesive pressure term $\frac{a}{(v-l)^2}$ in the equation of state.

One 15° calorie = 4.182 joules.*
One 15° B.t.u. = 777.17 standard ft. lb.
Absolute temperature of the ice-point: 273.1° C. or 459.58° F.

* This value is very nearly identical with the mean value, 4.1826 joules, obtained from a recomputation of Barnes work by A. W. Smith (*Phys. Rev.*, 1911).

The Thermodynamic Properties of Ammonia

1. FUNDAMENTAL THERMODYNAMIC RELATIONS

THE First Law of Thermodynamics requires that the heat absorbed dQ from the surroundings by a system which undergoes any change in state be equal to the increase dU in its internal energy plus the work dW produced in the surroundings. Since the work commonly consists in a change in volume dv against a pressure p, this relation is commonly expressed by the equation *

$$dQ = dU + p\,dv. \tag{1}$$ †

The quantity dQ, although of infinitesimal magnitude, is not a differential of any finite quantity which, like the internal energy U, is fully determined by the state of the system. It is therefore convenient for many purposes to consider another energy quantity dH which is defined by the equation

$$dH = dU + d\,(pv) \tag{2}$$

and which therefore is related to dQ in the way expressed by the equation

$$dH = dQ + v\,dp.$$

The quantity dH is evidently a complete differential, — one whose value is fully determined by the change in state of the system (since the values of dU and $d\,(pv)$ are so determined).

Various useful relations may be deduced from these equations by expressing the state of the substance (constituting the system) in terms of the variables p, v, and T. We shall consider in connection with equation (1) first the case where the independent variables are p and T and then the case where they are v and T.

Differentiating equation (1) with respect to T we get

$$\left(\frac{\partial Q}{\partial T}\right)_p = C_p = \left(\frac{\partial U}{\partial T}\right)_p + p\left(\frac{\partial v}{\partial T}\right)_p. \tag{3}$$

* It is customary in writing thermodynamic equations to sometimes insert a factor J or its reciprocal, depending on the units employed. In the equations here presented this factor has not been inserted. The simplification may be obtained by suitably choosing the units.

† In representing this heat-quantity Clausius wrote dQ to indicate that the quantity of heat was infinitesimal. However, dQ is not the differential of a known finite quantity Q, and some writers make use of other notations to avoid a misunderstanding of the quantity. The element dH, on the other hand, is evidently a perfect differential.

But
$$dU = \left(\frac{\partial U}{\partial T}\right)_p dT + \left(\frac{\partial U}{\partial p}\right)_T dp.$$

and it may be easily shown * that $\left(\frac{\partial U}{\partial p}\right)_T = - T\left(\frac{\partial v}{\partial T}\right)_p - p\left(\frac{\partial v}{\partial p}\right)_T$, and since $dv = \left(\frac{\partial v}{\partial T}\right)_p dT + \left(\frac{\partial v}{\partial p}\right)_T dp$, (1) may be written

$$dQ = C_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp. \tag{4}$$

From (4) may be written the specific heats along the saturation line of either the liquid or vapor,† or

$$C_s = C_p - T\left(\frac{\partial v}{\partial T}\right)_p \frac{dp}{dT} = C_p - \left(\frac{\partial v}{\partial T}\right)_p \cdot \frac{L}{v_1 - v_2} \tag{5}$$

since $T\frac{dp}{dT}(v_1 - v_2) = L$. Thus the difference in the specific heats along the saturation lines of liquid and vapor may be written

$$C_{s_1} - C_{s_2} = C_{p_1} - C_{p_2} - \frac{L}{v_1 - v_2}\left[\left(\frac{\partial v_1}{\partial T}\right)_{p_s} - \left(\frac{\partial v_2}{\partial T}\right)_{p_s}\right]. \tag{6}$$

The specific heat of a liquid as measured is usually that defined by (5), while it is impossible to measure C_{s_1} directly. By means of the equation

$$C_{p_1} - C_{p_2} = \frac{dL}{dT} - \frac{L}{T} + T\frac{dp}{dT}\left[\left(\frac{\partial v_1}{\partial T}\right)_p - \left(\frac{\partial v_2}{\partial T}\right)\right]$$

one obtains easily from (6) $C_{s_1} - C_{s_2} = \frac{dL}{dT} - \frac{L}{T}$.

It is evident that since $\frac{dL}{dT}$ is negative, C_{s_1} may be negative or positive. If C_{s_1} is negative the vapor would superheat on compression.

From (4) the expression for the entropy becomes

$$\Phi = \int\frac{dQ}{T} = \int\frac{C_p dT}{T} - \int\left(\frac{\partial v}{\partial T}\right)_p dp + \Phi_0, \tag{7}$$

and accordingly it follows on differentiating that

$$\left.\begin{aligned}\left(\frac{\partial \Phi}{\partial T}\right)_p &= \frac{Cp}{T}, \\ \left(\frac{\partial \Phi}{\partial p}\right)_T &= -\left(\frac{\partial v}{\partial T}\right)_p.\end{aligned}\right\} \tag{8}$$

The first of these equations differentiating with respect to p and the second with respect to T may be equated, giving the equation

$$\left(\frac{\partial C_p}{\partial p}\right)_T = - T\left(\frac{\partial^2 v}{\partial T^2}\right)_p.$$

* Max Planck, "Thermodynamik," 3rd ed., page 128.

† The subscript 1 will refer to the vapor phase and 2 to the liquid phase.

The first of equations (8) is a necessary condition of consistency which applies to tables of thermodynamic properties. For example, the differences in the total heats at constant pressure are the values of the mean specific heat between the two temperatures at which the difference is taken. This quantity divided by the average absolute temperature should be equal to the difference in the entropies for the corresponding temperatures.

The choice of v and T as independent variables leads to a general expression for dQ. For this purpose the definition $\left(\frac{\partial U}{\partial T}\right)_v = C_v$ and the equation $\left(\frac{\partial U}{\partial v}\right)_T = T\left(\frac{\partial p}{\partial T}\right)_v - p$ are needed. Proceeding in the same manner as with equation (4) there is obtained

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv. \tag{9}$$

From this equation it follows at once that the specific heats along the saturation line may be written

$$C_s = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \frac{dv}{dT}, \tag{10}$$

and the difference of the specific heats becomes

$$C_{s_1} - C_{s_2} = C_{v_1} - C_{v_2} + T\left[\left(\frac{\partial p}{\partial T}\right)_{v_1} \cdot \frac{dv_1}{dT} - \left(\frac{\partial p}{\partial T}\right)_{v_2} \cdot \frac{dv_2}{dT}\right]. \tag{11}$$

If C_s is replaced by C_p one obtains the familiar relation

$$C_p = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \cdot \left(\frac{\partial v}{\partial T}\right)_p, \tag{12}$$

and the difference between C_s and C_p is evidently

$$C_s - C_p = T\left(\frac{\partial p}{\partial T}\right)_v \left[\frac{dv}{dT} - \left(\frac{\partial v}{\partial T}\right)_p\right]. \tag{13}$$

The equation for the entropy and its derivatives becomes

$$\Phi = \int \frac{C_v dT}{T} + \int\left(\frac{\partial p}{\partial T}\right)_v dv + \Phi_0, \tag{14}$$

$$\left.\begin{aligned} \left(\frac{\partial \Phi}{\partial T}\right)_v &= \frac{C_v}{T}, \\ \left(\frac{\partial \Phi}{\partial v}\right)_T &= \left(\frac{\partial p}{\partial T}\right)_v. \end{aligned}\right\} \tag{15}$$

Applying to (15) a process similar to that employed with equations (8) leads to the equation

$$\left(\frac{\partial C_v}{\partial v}\right)_T = T\left(\frac{\partial^2 p}{\partial T^2}\right)_v.$$

Returning to equation (2) it follows as with (4) that

$$dH = C_p dT - \left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]dp \tag{16}$$

and

$$dH = \left[C_v + v\left(\frac{\partial p}{\partial T}\right)_v\right]dT + \left[T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T\right]dv. \tag{17}$$

For the specific heats at constant pressure and constant volume the two equations lead to the equations

$$\left.\begin{aligned}\left(\frac{\partial H}{\partial T}\right)_p &= C_p,\\ \left(\frac{\partial H}{\partial T}\right)_v &= C_v + v\left(\frac{\partial p}{\partial T}\right)_v.\end{aligned}\right\} \tag{18}$$

The specific heats at constant pressure are seen to be equivalent while the specific heat at constant volume is greater than the specific heat defined from equation (1). The specific heat along the saturation line becomes

$$\begin{aligned}\gamma_s = \frac{dH}{dT} &= C_p - \left[T\left(\frac{\partial v}{\partial T}\right) - v\right]\frac{dp}{dT} \qquad (19)\\ &= \left[C_v + v\left(\frac{\partial p}{\partial T}\right)_v\right] + \left[T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T\right]\frac{dv}{dT}.\end{aligned}$$

If the relation $pv = RT$ is applied to (16) and (17) there results for the former $dH = C_p dT$ while (17) becomes $dH = (C_v + R)\,dT = C_p\,dT$. The difference in the saturation specific heats is

$$\gamma_{s_1} - \gamma_{s_2} = C_{p_1} - C_{p_2} - T\frac{dp}{dT}\left[\left(\frac{\partial v_1}{\partial T}\right)_p - \left(\frac{\partial v_2}{\partial T}\right)_p\right] + \frac{L}{T}. \tag{20}$$

Taking account of the equation for $C_{p_1} - C_{p_2}$ in equation (5) and L one obtains the relation

$$\gamma_{s_1} - \gamma_{s_2} = \frac{dL}{dT}. \tag{21}$$

The equation $C_{s_1} - C_{s_2} = \frac{dL}{dT} - \frac{L}{T}$ provides a further relation which assists in comprehending the difference between the definition of heat contained in equations (1) and (2). Writing $\Delta C_{s_{12}}$ for this equation and $\Delta\gamma_{s_{12}}$ for (21) it follows that

$$L = T\,(\Delta\gamma_{s_{12}} - \Delta C_{s_{12}}). \tag{22}$$

The equations for the Joule-Thomson experiment are at once deducible from equations (16) and (17); assuming that H is constant one obtains:

$$\frac{dT}{dp} = \frac{T\left(\frac{\partial v}{\partial T}\right)_p - v}{C_p}. \tag{23}$$

$$\frac{dT}{dv} = \frac{T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T}{C_v + v\left(\frac{\partial p}{\partial T}\right)_v}. \tag{24}$$

The above relations serve as a general basis for using the quantity defined by either (1) or (2). The present tables are based on equation (1), which represents the heat added to a fluid within an envelope, while (2) evidently represents the quantity of heat supplied when a fluid is forced to flow from one p, v, T condition to another p, v, T condition.

General Formulæ Deducible from Equation (1)

Independent Variables p, T.

$$dQ = C_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp.$$

$$C_s = C_p - T\left(\frac{\partial v}{\partial T}\right)_p \frac{dp}{dT}.$$

$$\left(\frac{\partial U}{\partial p}\right)_T = -T\left(\frac{\partial v}{\partial T_p}\right) - p\left(\frac{\partial v}{\partial p}\right)_T.$$

$$\Phi = \int \frac{C_p dT}{T} - \int \left(\frac{\partial v}{\partial T}\right)_p dp + \Phi_0.$$

$$\left(\frac{\partial \Phi}{\partial T}\right)_p = \frac{C_p}{T}.$$

$$\left(\frac{\partial \Phi}{\partial p}\right)_T \quad -\left(\frac{\partial v}{\partial T}\right)_p.$$

$$\left(\frac{\partial C_p}{\partial p}\right)_T = -T\left(\frac{\partial^2 v}{\partial T^2}\right).$$

For Q Constant

$$\left(\frac{dT}{dp}\right)_Q = \frac{T\left(\frac{\partial v}{\partial T}\right)_p}{C_p}.$$

Independent Variables v, T.

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv.$$

$$C_s = C_v + T\left(\frac{\partial p}{\partial T}\right)\frac{dv}{dT}.$$

$$\left(\frac{\partial U}{\partial v}\right)_T = T\left(\frac{\partial p}{\partial T}\right)_v - p.$$

$$\Phi = \int \frac{C_v dT}{T} + \int \left(\frac{\partial p}{\partial T}\right)_v dv + \Phi_0.$$

$$\left(\frac{\partial \Phi}{\partial T}\right)_v = \frac{C_v}{T}.$$

$$\left(\frac{\partial \Phi}{\partial v}\right)_T = \left(\frac{\partial p}{\partial T}\right)_v.$$

$$\left(\frac{\partial C_v}{\partial v}\right)_T = T\left(\frac{\partial^2 p}{\partial T^2}\right)_v.$$

For Q Constant

$$\left(\frac{dT}{dv}\right)_Q = -\frac{T\left(\frac{\partial p}{\partial T}\right)_v}{C_v}.$$

$$\left(\frac{\partial v}{\partial T}\right)_p \cdot \left(\frac{\partial p}{\partial v}\right)_T \cdot \left(\frac{\partial T}{\partial p}\right)_v = -1.$$

$$C_p - C_v = T\left(\frac{\partial p}{\partial T}\right)_v \cdot \left(\frac{\partial v}{\partial T}\right)_p = -T\left(\frac{\partial p}{\partial v}\right)_T \cdot \left(\frac{\partial v}{\partial T}\right)_p^2.$$

$$C_{p_1} - C_{p_2} = \frac{dL}{dT} - \frac{L}{T} + \frac{L}{v_1 - v_2}\left[\left(\frac{\partial v_1}{\partial T}\right)_p - \left(\frac{\partial v_2}{\partial T}\right)_p\right].$$

$$C_{s_1} - C_{s_2} = \frac{dL}{dT} - \frac{L}{T}.$$

General Formulæ Deducible from Equation (2)

Independent Variables p, T.

$$dH = C_p dT - \left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]dp.$$

$$\gamma_s = C_p - \left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]\frac{dp}{dT}.$$

$$\left(\frac{\partial H}{\partial T}\right)_p = \left(\frac{\partial Q}{\partial T}\right)_p = C_p.$$

$$\frac{1}{T}\left(\frac{\partial H}{\partial T}\right)_p = \left(\frac{\partial \Phi}{\partial T}\right) = \frac{C_p}{T}.$$

$$\left(\frac{\partial T}{\partial p}\right)_H = \frac{T\left(\frac{\partial v}{\partial T}\right)_p - v}{C_p} = \mu.$$

$$\left(\frac{\partial H}{\partial p}\right)_T = -\left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right] = -C_p\mu.$$

Independent Variables v, T.

$$dH = \left[C_v + v\left(\frac{\partial p}{\partial T}\right)_v\right]dT + \left[T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T\right]dv.$$

$$\gamma_s = \left[C_v + v\left(\frac{\partial p}{\partial T}\right)_v\right] + \left[T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T\right]\frac{dv}{dT}.$$

$$\left(\frac{\partial H}{\partial T}\right)_v = C_v + v\left(\frac{\partial p}{\partial T}\right)_v.^*$$

$$\frac{1}{T}\left(\frac{\partial H}{\partial T}\right)_v = \left(\frac{\partial \Phi}{\partial T}\right)_v + \frac{v}{T}\left(\frac{\partial p}{\partial T}\right)_v.$$

$$\left(\frac{\partial T}{\partial v}\right)_H = -\frac{T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T}{C_v + v\left(\frac{\partial p}{\partial T}\right)_v}.$$

$$\left(\frac{\partial H}{\partial v}\right)_T = T\left(\frac{\partial p}{\partial T}\right)_v + v\left(\frac{\partial p}{\partial v}\right)_T.$$

$$\gamma_{s_1} - \gamma_{s_2} = \frac{dL}{dT}.$$

$$H_1 - H_2 = U_1 - U_2 + p_1v_1 - p_2v_2.$$

2. FUNCTIONAL EXPRESSIONS FOR THE CHANGE OF VAPOR-PRESSURE WITH THE TEMPERATURE

A knowledge of the relation between the pressure and the temperature along the saturation line is of first importance in constructing a table of thermodynamic quantities. From this relation may be obtained: (1) the specific volumes of the saturated vapor through the equation of state of the vapor phase; (2) values of $\frac{dp}{dT}$ for use in calculating the heat of evaporation by the Clapeyron Equation. The problem of obtaining accurate values of $\frac{dp}{dT}$ depends evidently upon the accuracy with which it is possible to relate p to T by means of a suitable equation. Considerable attention has in the past been devoted to this subject, but most of the methods of

* Since $\left(\frac{\partial p}{\partial T}\right) = \frac{p}{T} = \frac{R}{v}$ from $pv = RT$ it follows that for a perfect gas

$$\left(\frac{\partial H}{\partial T}\right)_v = T\left(\frac{\partial \Phi}{\partial T}\right)_v + R = C_v + R = C_{p_0},$$

where C_{p_0} refers to the specific heat at constant pressure as the pressure approaches zero. It may be further observed that on applying the same pressure volume relation to $\left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]$ the specific heat γ_s becomes equivalent to C_p. C_{s_1} on the other hand reduces to $C_{s_1} = C_{p_1} - R\frac{d\log p}{d\log T}$.

attacking the problem have their starting point in certain integrations of the Clapeyron equation $L = T\frac{dp}{dT}(v_1 - v_2)$, which may also be written: $dp = \frac{L}{T(v_1 - v_2)}dT$. It is easily seen, for example, that the latter equation, L being represented by $L_0 + a_1T + a_2T^2 + \cdots + a_nT^n$, v_1 by $\frac{RT}{p}$, and neglecting v_2, leads to the expression

$$\log p = \int \frac{L_0 + a_1T + a_2T^2 + \cdots + a_nT^n}{RT^2}dT + m \ldots$$

$$= -\frac{L_0'}{T} + a_1 \log T + a_2'T + \cdots + a_n'T^{n-1} + m, \qquad (25)$$

where $L_0' = \frac{L_0}{R}$ and a_1', a_2' have an obvious significance, m being a constant of integration calculable from a single value of p at a definite temperature.

In practice the constants of formula (25) are evaluated from several smoothed data suitably spaced with reference to the temperature. Consideration reveals at once, however, that a method of evaluating the constants is to be preferred whereby the inevitable inconsistencies of the experimental data will be disclosed and eliminated. The following method of procedure was accepted in the case of ammonia as a means of accomplishing this object.

Van der Waals inferred from certain considerations relative to his equation of state that

$$\log \frac{p_c}{p} = a\left(\frac{T_c}{T} - 1\right) \qquad (26)$$

should be valid where a is a constant. It is well known, however, that a is not constant, but varies with T.* If, however, it is possible to represent a accurately as a function of T the correct relation between p and T will result. Writing (26) as $T\left(\frac{\log p_c/p}{T_c - T}\right) = a$ it is possible to calculate values of a throughout the extent of the vapor-pressure data available. For a number of substances a lies on a curve resembling a parabola.

It is a matter of experience that it is impossible to draw a representative curve through experimental data where a minimum occurs, but to avoid this difficulty it is only necessary to plot the a's with $(T_c - T)$ as an ordinate and by extrapolation obtain the value of a indefinitely near the critical temperature. This section of the curve is fortunately very nearly linear. Assuming that a may be represented as

$$a_0 + a_1(T_c - T) + a_2(T_c - T)^2 + \cdots + a_n(T_c - T)^n,$$

* See H. Happel, *Ann. d. Physik*, **13**, 340 (1904); also Marks, *Jour. Am. Soc. Mech. Eng.*, **33**, 563 (1911).

a_0 would be the value of a indefinitely near the critical temperature. If now the variable is changed to

$$Z = \frac{a - a_0}{T_c - T} = a_1 + \cdots + a_n (T_c - T)^{n-1},$$

the difficulty of being obliged to draw a smooth curve through a minimum will be avoided.*

Rewriting (26), taking account of the Z function, there results

$$\log p = -\frac{Z (T_c - T)^2 + a_0 T_c}{T} + (\log p_c + a_0);$$

writing $\quad a_0 T_c = \omega \quad$ and $\quad (\log p_c + a_0) = m,$

$$\log p = -\frac{Z (T_c - T)^2 + \omega}{T} + m. \tag{27}$$

This equation in practice is most convenient for calculations since $Z (T_c - T)^2$ may be obtained with sufficient accuracy with a 20-inch slide rule; there remaining only the division of $\omega + Z (T_c - T)^2$ by T to be carried out by logarithms. If desired, the critical constants may be absorbed in the constants of the equation

$$\log p = -\frac{b}{T} + C + dT + eT^2 + \cdots. \tag{28}$$

3. THE VAPOR-PRESSURE DATA FOR AMMONIA

The most reliable and systematic data in connection with the vapor-pressure of ammonia are due to Regnault.† Other measurements have been made at isolated sections of the vapor-pressure temperature curve by Faraday,‡ Blumcke,§ Brill,|| and Davies.¶ The data due to all these observers have been admirably treated by Goodenough and Mosher** and also recently by Holst.†† In the Holst treatment of the data a few new measurements carried out by Holst were included. These additions consist of three measurements between −32° and −44° C. and also one each at 19.58° and 45.05° C. The Holst treatment, however, does not lead to values which differ materially from the Mosher values although Holst perceived that the Regnault pressures above zero were too low.

The vapor-pressure values used in the present tables depend entirely on the data obtained at the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. Measurements of pressure were made by equilibrating the pressure exerted by the ammonia

* Sometimes, owing to inaccurate data, the value of a_0 at the critical temperature is difficult to determine. For several substances, however, it has been found that no appreciable error is made by assuming 3.00 as the value of a_0.

† *Mem. de l'Inst. de France*, **26**, 598 (1847).

‡ *Phil. Trans.*, **135**, 170 (1845).

§ *Wiedemann's Annalen*, **34**, 10 (1888).

|| *Ann. der Physik*, **21**, 170 (1906).

¶ *Proc. Roy. Soc.*, **78**–A, 41 (1906).

** *Univ. of Illinois Bull.*, **18** (1913).

†† *Les prop. therm. de l'ammoniaque et du chlorure de méthyle*, Leiden (1914).

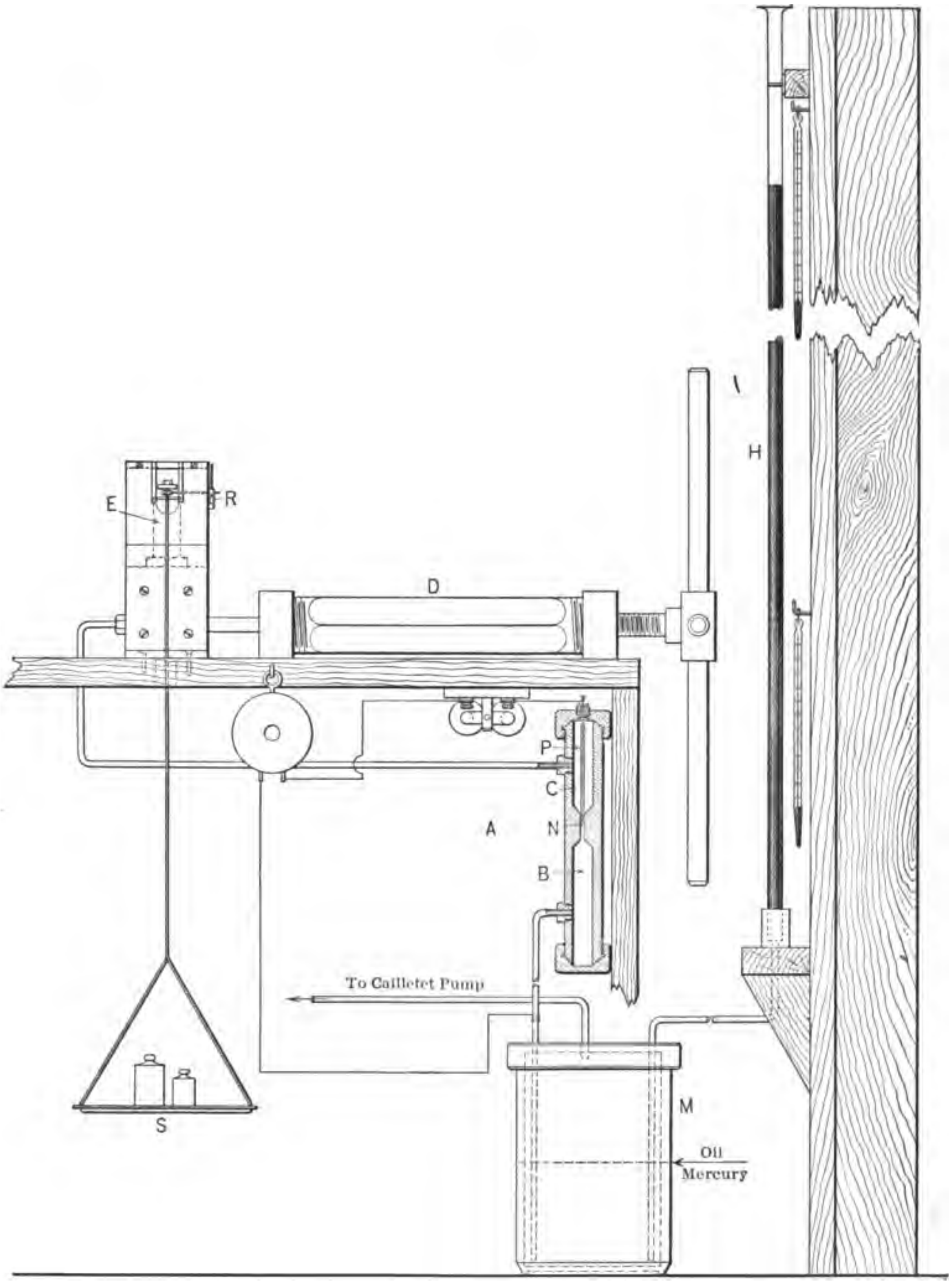

FIG. 1.

against a piston by means of weights, and the final temperature measurements were made with a platinum resistance thermometer. The calibration of the pressure piston was accomplished by direct comparison with a column of mercury 12.8 meters in length. The device used for determining the equilibrium of the piston is illustrated in Fig. 1.

The mercury-in-glass column is indicated at H and communicates with the mercury in the steel cylinder at M. Leading from the cover of the steel cylinder are two steel tubes, one of which passes to the Cailletet pump which serves to elevate the mercury in the column M, while the other leads from the mercury to the steel device A. From A the oil tube connects with the pressure-measuring piston E, which has attached a motor-driven device at R for reciprocating the piston through an angle regularly. The adjusting of the oil on the piston side of A is accomplished by the screw-pump D. The temperature of the mercury column was read by means of thermometers placed at intervals along the column. The average temperature was then obtained by graphically determining the area on a rectangular diagram between the curve drawn through the temperature readings and the axis of column length. Division of the area by the column length thus gives the true average temperature.

It has always been customary to consider the piston in equilibrium when the piston appeared to neither rise nor fall. Since the correct calibration of the piston was a matter of primary importance considerable study was devoted to the problem of investigating the sources of error that attend detecting the true equilibrium of the piston. The method finally adopted consisted in observing the motion of the mercury at its junction with the oil at N in the steel capillary A by means of a telephone receiver connected in series with the secondary of a small induction coil adjusted to the proper frequency. The connections of the circuit are evident from the drawing. An insulating joint is provided at I through which passes the pointed platinum wire (p). When the weights on the scale pan S are insufficient the mercury will rise in the capillary at N and excite the telephone receiver. If it is desired to confirm the observation the circuit is broken by the injection of a minute quantity of oil by means of the pump D. The weights are adjusted until the removal of 0.1 gram causes contact to be made and the addition of 0.1 gram permanently prevents contact. Since the diameter of the capillary was about 0.15 cm. while the diameter of the piston was about 0.476, a motion of 0.1 cm. of mercury in the capillary corresponds with only 0.01 cm. vertical motion of the measuring piston. The leak of oil at the piston, of course, would cause the mercury to make contact even if equilibrium had been attained. The diameter of the hole into which the piston was fitted, however, was only 0.01 mm. greater than the piston and observations on the rate of leak were made. The rate of leak under the calibrating pressures was 7×10^{-4} c.c. per hour per atmosphere and thus the arrangement permitted readings being taken rapidly and accurately. The average of two sets of the gauge calibrations agreed to about one part in eight thousand. The telephone device was employed in all the final vapor-pressure measurements and an improved thermostatic arrangement, containing the ammonia under measurement, permitted a given temperature to be maintained constant to within 0.005° C. for long periods of time. The real difficulty in making accurate measurements lies, however, in securing true equilibrium between the vapor and liquid. To aid in securing equilibrium, the ammonia in the container was agitated by shaking the container during the course of the measurements.

The data of other observers in relation to the measurements carried out at the Research Laboratory of Physical Chemistry is illustrated in a Z plot, Fig. 2. It will be noted that the Z function serves well in making evident inconsistencies in the trend of the various observations.

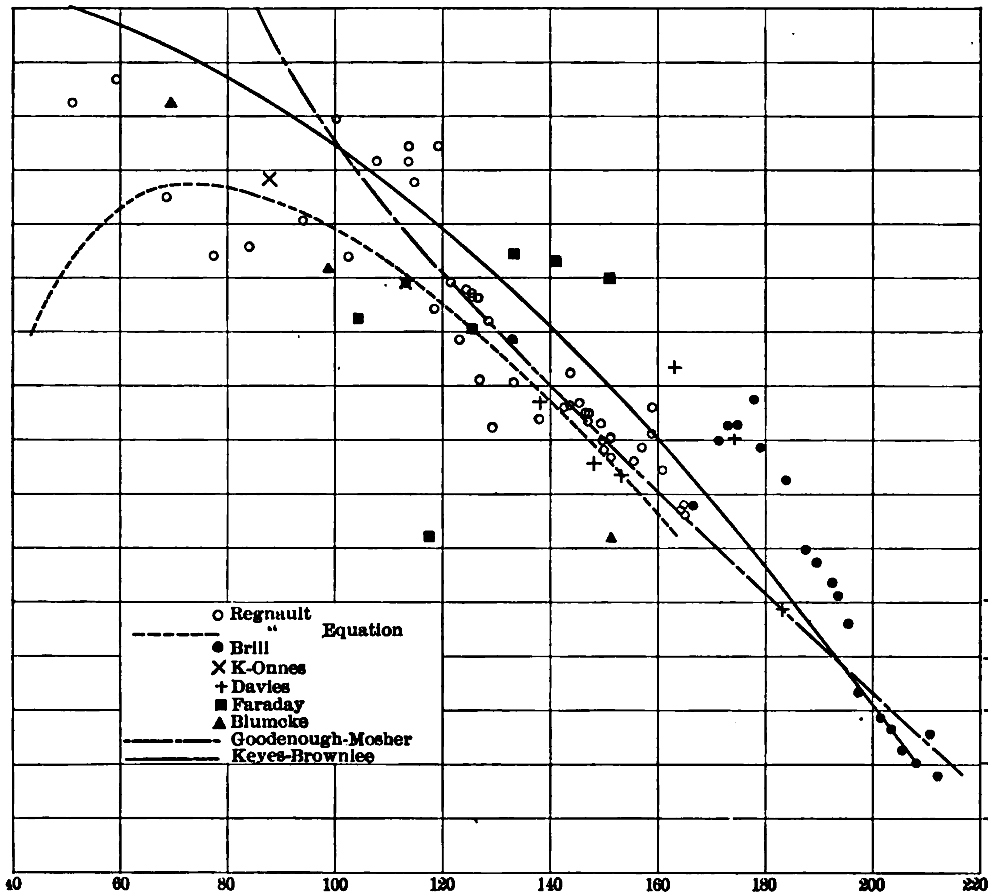

FIG. 2.

The equations of the vapor pressure are as follows:

$$\log_{10} p = 7.91121 - \frac{1209.88 + Z\,(T_c - T)^2}{T}. \tag{29}$$

$$Z = 10^{-4}\,[-11.901 + 1.0018 \cdot 10^{-2}\,(T_c - T) + 3.2715 \cdot 10^{-4}\,(T_c - T)^2],$$

or eliminating the critical constant T_c,

$$\log_{10} p = -\frac{1969.65}{T} + 16.19785 - 0.0423858\,T + 5.4131 \cdot 10^{-5}\,T^2 - 3.2715 \cdot 10^{-8}\,T^3. \tag{30}$$

The critical constants are as follows:

$$T_c = 132.9° \text{ C.}$$
$$p_c = 112.31 \text{ atmos.}$$
$$v_c = 4.236 \text{ cc. per gram.}$$

The value given of the critical volume was derived from the vapor and liquid saturation specific volumes by means of the rule of the "rectilinear diameter."* The formula for $\frac{dp}{dT}$ follows from the above vapor-pressure equation in its second form and reads:

$$\frac{dp}{dT} = p\left[\frac{4535.28}{T^2} - 0.074571 + 2.49282 \cdot 10^{-4}\, T - 2.25987 \cdot 10^{-7}\, T^2\right]. \quad (31)$$

4. THE SPECIFIC VOLUME OF THE LIQUID AMMONIA

Before discussing the experimental data the question of the empirical equation which is to represent the specific volumes of the liquid may be considered. After modifying it somewhat the equation of Avenarius seemed to be the best suited for the purpose. The Avenarius equation reads:

$$v = a + b \log (T_c - T), \quad (32)$$

where T_c is the critical temperature. Any empirical equation must satisfy the terminal conditions of the curve at the critical temperature, and must yield a finite value for the specific volume at absolute zero, assuming that superfusing could, of course, take place to that extent. The equation does satisfy the latter condition, but gives an infinite value to the volume at the critical temperature. Granting its validity, if v is plotted with the logarithm of $(T_c - T)$ on a rectangular diagram a straight line should result. It is needless to state that such a condition could scarcely be expected to hold. Since, however, the Avenarius form of equation does rectify the v, T curve to a considerable extent, the procedure adopted for the ammonia liquid volumes was to assume the equation $v = a - \log (\alpha - T)$, where α is a function of the temperature. To use the equation it is merely necessary to determine the constant a for some accurately known specific volume far below the critical temperature, arbitrarily assuming α to have the same numerical value as the critical temperature. Values of α for all the remaining data can then be calculated and plotted with the temperature as a coördinate. The curve for ammonia resembles a parabola with a minimum at about 48 degrees. The total change in α is only a few per cent, and its representation as a function of the temperature is comparatively easy. The particular advantage of the method lies in the fact that slight inconsistencies in the experimental data become at once evident. In Fig. 3 the α values corresponding to the experimental data of Dieterici and Lange are plotted on

* *Compt. rend.* **102**, 1202 (1886); *Compt. rend.* **104**, 1563 (1887); *Phil. Mag.*, **50**, 291 (1900).

the same scale as the Research Laboratory experimental data, the latter being represented by the curve. The dotted line represents the smoothed data as given by Mosher.

It is evident that there is lack of agreement between the Lange data and the present work. It is also evident from the figure that the specific

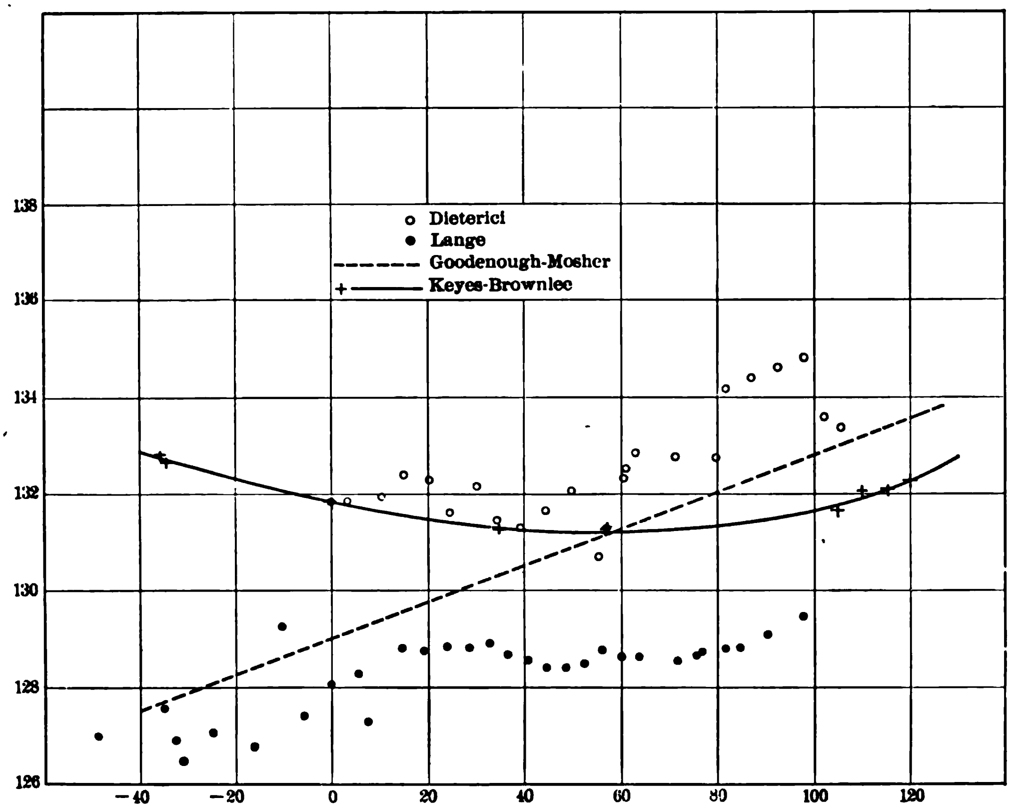

FIG. 3.

volume curve can be accurately obtained from about five exact measurements of the specific volume at suitably selected temperatures. This latter fact led Mr. Brownlee to measure accurately the volumes at the temperatures −33.5°, 0°, 35°, 68°, 110°, 120°, 125°, and the full line in the figure is drawn through the volumes found at these temperatures.

TABLE I. SPECIFIC VOLUME OF LIQUID AMMONIA

Temperature, °C.	α from R. L. of P. C. Data	Dieterici	Lange	Brownlee
−50	133.22	....	1.4375	1.4227
−30	132.61	....	1.4895	1.4745
−10	132.06	....	1.5480	1.5332
0	131.83	1.5656	1.5795	1.5657
+20	131.42	1.6342	1.6503	1.6387
40	131.21	1.7227	1.7383	1.7256
60	131.225	1.8250	1.8487	1.8331
80	131.40	1.9595	1.9982	1.9747
100	131.775	2.1525	....	2.1836
120	132.49	....	....	2.5891

Table 1 gives a survey of the agreement between the Lange* and Dieterici values and the values based on the Research Laboratory measurements. Attention may be directed to the agreement in the value obtained by Dieterici at 0° C. The deviations in the Dieterici measurements and the recent measurements lie in the direction of the difference between the hydrogen scale and the mercury scale. The two latter scales, of course, agree at the freezing point and the boiling point of water. Without knowing the kind of glass from which the mercury thermometer was constructed it would be difficult to correct the Dieterici data. The maximum difference between the two thermometer scales occurs at about 40° C. and would likely not exceed 0.12° C.† A greater error than the thermometric error, however, would result from the temperature expansion of the glass container used and its dilation due to pressure. The latter cannot be calculated but must be determined experimentally, and even then the glass used must be carefully annealed after having been blown. The temperature expansion of German soda glass is about 3.0×10^{-5}, which gives 0.0021 as the correction due to temperature expansion. The thermometric error amounts to 0.0006 c.c., thus giving a total of 0.0027 c.c. as the amount by which the Dieterici value is too small. Dieterici‡ gives 1.7227 as the result of smoothing his experimental data. The value arrived at in the recent work is 1.7255 c.c. Correcting the Dieterici value leads to the value 1.7254 c.c. The attempt to correct the Dieterici work at higher temperatures is difficult owing to the unknown stretch of the glass due to the increasing pressure. It will be noticed from the α figure that the Dieterici experimental values become increasingly small as the temperature increases, which would be predicted in fact owing to the pressure and temperature dilation effect.

5. EQUATIONS OF STATE IN GENERAL

The state of any substance in either of its three phases may be represented as some function of the variables p, v, and T, but for practical requirements in connection with ammonia refrigeration machines it is the vapor phase which is required to be accurately represented by such a function. The number of formulæ§ proposed are very numerous, but

* The volumes inserted in the table were calculated from Fig. 3 by drawing a representative line through the Lange values.

† See Guillaume: "Traité Pratique de la thermométrie de précision."

‡ Winkelmann, Handbuch der Physik, **3**, 965.

§ Starting with the general equation of the Joule-Thomson experiment (23) the Callendar equation may be derived by assuming μ to depend on the temperature; as $\frac{\alpha}{T^n}$, and independent of the pressure. For example:

$$\frac{T\left(\frac{\partial v}{\partial T}\right)_p - v}{C_p} = \frac{dT}{dp} = \mu = \frac{\alpha}{T^n}.$$

If C_p be assumed constant the equation may be written $\frac{T\,dv - v\,dT}{T^2} = C_p \frac{\alpha}{T^{n+2}}$. Integrating equations of the general form suggested by Callendar* seem to have received the preference. It seems not unlikely that this preference may be attributed to the fact that formulæ of the Callendar type give the volume explicitly, and such an equation is most convenient in preparing tables of "properties" since volumes at constant pressure are desired. The matter of primary importance would appear, however, to concern the general consistency of the deductions and inferences which follow from the proposed equation rather than the saving of labor to the calculator in preparing tables of "properties."

The history of the subject of equations of state may be considered as included in the much broader attempt to increase our understanding concerning the continuity of matter from the point of view of an explanation of the phenomena in terms of the motion of the discreet particles of which the substances are assumed to be composed. Van der Waals,† considerations led him to a rational equation which represented the continuity of the vapor and liquid phases in its general aspects. The equation of van der Waals, however, while leading to many generalizations fails to represent accurately the p, v, T relations, even in the vapor phase, with sufficient accuracy. Many of the numerous formulæ, for the most part wholly empirical, which have appeared since van der Waals' work was published, may accordingly be regarded as an attempt to provide an equation which would represent with sufficient accuracy the p, v, T relations of substances required in technical work. The vapor phase of water for example has received much attention on account of its technical importance, and an empirical equation due to Knoblauch, Linde, and Klebe ‡ has been accepted as representing the vapor phase accurately within the range required in engineering practice. The equation reads:

$$v = \frac{BT}{p} - (1 + ap)\left[C\left(\frac{373}{T}\right)^3 - D\right].$$

this equation there results $$\frac{v}{T} = f(p) - \frac{C_p}{n+1}\frac{\alpha}{T^{n+1}}.$$

When the temperature is high and the volume large $pv = RT$ may be assumed to represent the behavior of the gas. This identifies $f(p)$ with $\frac{R}{p}$.

The complete Callendar equation may then be written

$$v = \frac{RT}{p} - C_p\frac{\alpha}{n+1}\frac{1}{T^n}.$$

* *Proc. Roy. Soc.*, **67**, 266 (1900).

† J. D. van der Waals, Kontinuität, 1872. See also the Van't Hoff lectures.

NOTE. — The van der Waals equation reads

$$p = \frac{RT}{v-b} - \frac{a}{v^2},$$ where a and b are constants.

‡ *Verein deutscher Ingenieure*, Heft. **21** (1905). Berlin. Also see Winkelmann, *Handbuch der Physik*, Vol. III, 1121.

This equation represents the somewhat restricted range of the measurements made by Knoblauch, Linde, and Klebe, but begins to fail as small volumes are approached.* If $\frac{\partial^2 p}{\partial T^2}$ is formed from the equation above it turns out to be a function of p and T. Examination of the Linde data just mentioned shows on the other hand that the pressure is a linear function of the temperature which would make $\frac{\partial p^2}{\partial T^2}$ equal to zero. The consequence of $\frac{\partial^2 p}{\partial T^2}$ being equal to zero or a function of the temperature is of considerable significance because of its relation to the general equation:

$$\left(\frac{\partial C_v}{\partial v}\right)_T = T\left(\frac{\partial^2 p}{\partial T^2}\right)_v.$$

If $\left(\frac{\partial^2 p}{dT^2}\right)_v$ is a function of the volume, $[C_v]_T$ must be a function of the volume; but if the second derivative of the pressure is zero, C_v is a function of the temperature solely. Unfortunately it is not easy to measure C_v† and therefore C_p is measured. The general relation $C_v = C_p - T\left(\frac{\partial p}{\partial T}\right)_v \cdot \left(\frac{\partial v}{\partial T}\right)_p$ permits on the other hand the computation of C_v only when $T\left(\frac{\partial p}{\partial T}\right)_v \cdot \left(\frac{\partial v}{\partial T}\right)_p$ is accurately known. The strongest proof of the independence of C_v from the volume is therefore at present furnished by the linear increase of the pressure when the vapor is heated at constant volume.

* Mr. R. D. Mailey, at the Research Laboratory, has made a very careful study of the properties of water, liquid, and vapor phase, and over a range of temperature exceeding the critical temperature and to pressures above 500 atmospheres. One of the writers has had the privilege of examining the data in the vapor phase and finds the equation used in these tables to apply. This would indicate that equations of the type of the Linde Equation are defective in form.

† J. Joly. *Proc. Roy. Soc.*, **41**, 352 (1886), (1887); *Chem. News*, **58**, 271 (1888); *Proc. Roy. Soc.*, **45**, 218 (1890); *Phil. Trans.*, **182a**, 73 (1892), **185a**, 943 (1894); *Proc. Roy. Soc.*, **55**, 390 (1894).

Joly employing his steam calorimeter measured the specific heat at constant volume of air, carbon dioxide, and hydrogen. The measurements of the latter substance were not carried to completion. A. Winkelmann (Winkelmann, *Handbuch der Physik*, Vol. III, 228) discusses the air data and points out that Joly's values are too large from a comparison of the ratio C_p/C_v. This latter quantity has been measured by a number of observers and the ratio is close to 1.405. The Joly values of C_v on the other hand lead to 1.390. The values obtained by Joly moreover seem to indicate that C_v is a function of the volume. Consideration shows, however, that Joly's C_v is in reality $C_v + T\left(\frac{\partial p}{\partial T}\right)_v \frac{dv}{dT} + \Delta H$, where dv is the sum of combined thermal expansion and pressure expansion of the copper sphere which was used to contain the gas under measurements. The term ΔH represents a quantity of heat absorbed by the copper sphere containing the gas, which results from the altered heat capacity of copper under tension and also the absorption of heat due to the stretching of the copper sphere when the pressure increases from the pressure at ordinary temperature to the pressure at the final temperature of the steam. The latter quantity is small, but becomes significant at the higher pressures employed by Joly. A note discussing and recalculating Joly's experiments is in course of preparation.

The Joule-Thomson measurements* have been frequently regarded as furnishing a crucial test of the correctness of form or the accuracy with which the constants may have been determined in an accepted equation of state. The Joule-Thomson numbers indeed do furnish a sound basis for testing equations of state, but the measurements are unfortunately most difficult to make and experimenters who have occupied themselves with the problem have not always arranged to carry out the measurements in such a way as to yield numbers readily interpreted in connection with the Joule-Thomson thermodynamic equation of the porous plug experiment. For example, while the equation requires the difference in temperature of the gas before and after the plug for a small difference in pressure very often what has been measured is the difference in temperature corresponding to a large difference in pressure.†

The Joule-Thomson measurements in the case of ammonia are due to Wobsa.‡ Wobsa's measurements exhibit the anomaly of making the coefficient μ diminish with increasing pressure at constant temperature which would lead to the inference that ammonia vapor compressed at constant temperature approaches more nearly the ideal gas state.§ From measurements of the boiling point of liquid ammonia supplied in wrought iron cylinders it is possible to compute the per cent of water present by means of the Van't Hoff formula. The per cent of water appears to be of the order of 0.5 to 0.7 per cent. The presence of water accordingly in the commercial ammonia employed by Wobsa may possibly account in part for the apparently anomalous trend in the measurements.¶ The Wobsa measurements have been admirably discussed by Goodenough and Mosher and nothing can be added to their treatment until further measurements have been made.

* A lucid discussion of this quantity is given in Noyes and Sherrill's *General Principles of Chemistry.*

† W. P. Bradley and C. F. Hale, *Phys. Rev.*, **29**, 258 (1909).

‡ *Zeitschr. f. d. ges. Kalte Industrie*, **61** (1907).

§ An ideal gas is one following the equation $pv = RT$ for which μ would be zero.

¶ In a mixture of two gases the constants of the equation (33) for any given constant composition would be a function of the constants of the components. For example, assume that (a) of the cohesive pressure term may be written, where x is the fraction of the first component:

$$a_x = a_1(x)^2 + 2\,a_{12}(x)(1-x) + a_2(1-x)^2,$$

a_{12} being the cohesive pressure constant for the unlike molecules. If the attraction were large between unlike molecules, as is the case for ammonia and water, a_{12} would be many times larger than either a_1 or a_2. The equation (33) used in connection with the Joule-Thomson equation (23) gives for moderate pressures:

$$\frac{dT}{dp} = \frac{\frac{2a}{RT} - \beta}{C_{p_0}}.$$

Now $\frac{2a}{RT}$ is the principal term of the numerator, and in a mixture, a and β would be replaced by a_x, β_x. From the comment above it is easily seen that a_x might be larger for a mixture than it would be for either pure substance alone since ammonia and water have considerable mutual affinity.

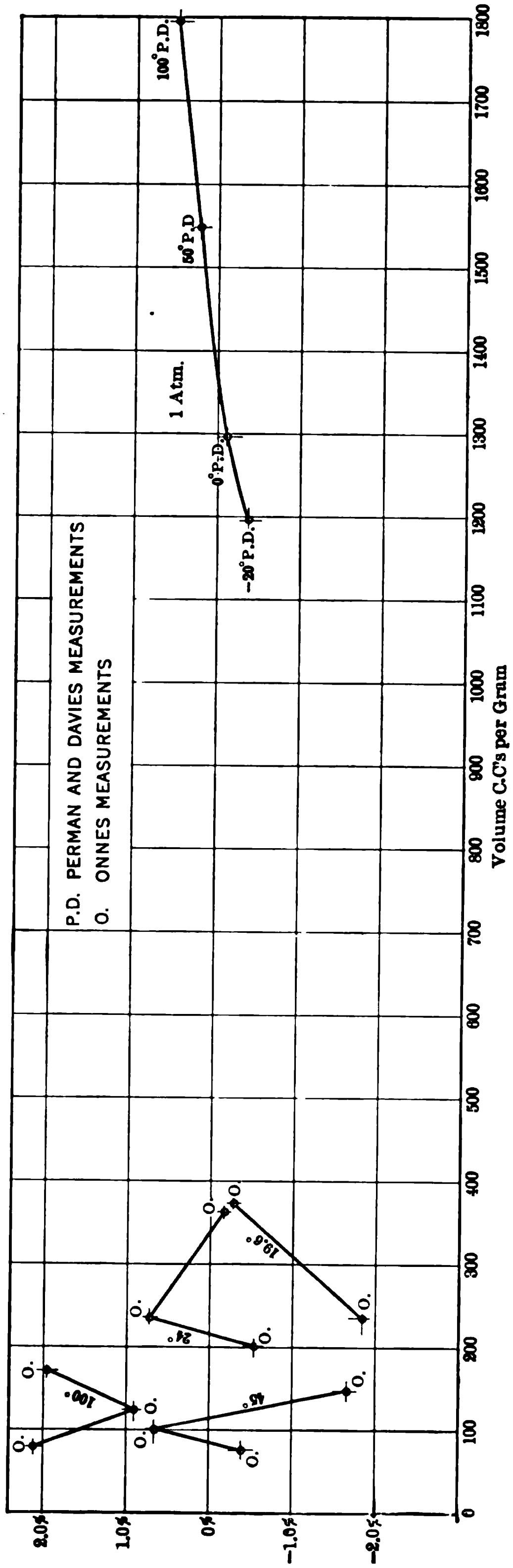

FIG. 4.

6. THE EQUATION OF STATE FOR AMMONIA VAPOR

The equation of state used in the computation of the present tables has already been briefly discussed in connection with a number of other substances.* The equation reads:

$$p = \frac{R}{v - \delta} T - \frac{a}{(v - l)^2}. \quad (33)$$

The constants of this equation for ammonia vapor have been derived from the measurements made at the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. The values of these constants are:

$$R = 4.8177;$$

$$\log_{10}\delta = 0.98130 - \frac{3.08}{v}$$

$$a = 34610.1; \text{ and } l = -1.173.$$

Small volumes and high pressures are best suited for the purpose of determining the constants since the deviations from the relation $pv = RT$ are greatest at small volumes. In the present case volumes less than 15 c.c. were not used in evaluating the constants of the equation above. A number of measurements were made at large volumes, but great difficulty was experienced in obtaining accurate data owing apparently to the adsorption phenomena due to the steel walls of the container.

The comparison of the work of other observers may be most

* Frederick G. Keyes, *A. S. R. E. Journal*, Vol. 1, 9 (1914).

easily compared with equation (33) by substituting the measured volumes and temperatures in the equation and comparing the pressures. It is perhaps better in the present instance, however, to compute the volumes for the measured pressures and temperatures. The result of such a comparison is given in Fig. 4, where the per cent volume difference is given at the calculated volumes. The Onnes* groups of data are substantially at constant temperature while the Perman and Davies measurements are at one atmosphere pressure. Holst states that the isotherm in the Onnes data at 45 degrees is in error. The magnitude or the nature of the error is not stated however. It is well known that ammonia is adsorbed on glass surfaces to a more marked extent than any other gas, consequently there exists the possibility that the somewhat erratic trend of the Onnes measurements may be due to this disturbing effect. If this were true it may be stated that as the temperature falls, increased adsorption would cause the volume to grow small too rapidly at constant pressure, while heating the glass bulb loaded at room temperature would cause ammonia to be given up and hence give too large a volume. Perman and Davies†

* H. Kamerlingh Onnes' "Report of the Third International Congress of Refrigeration," Sept. 15 to Oct. 1, 1913.

† Perman and Davies, to satisfy themselves that there was no adsorption, measured the density in two glass globes of different capacities. One bulb had a volume of about 0.5 liter, surface 3.22 dm², and the other 1.77 liters, surface 7.10 dm². The ratio of surfaces, accordingly, of the larger globe to the smaller is 2.2 times. Langmuir has measured the total quantity of water vapor evolved in a good vacuum from a glass surface, in passing to 360° C. The globe was a 40-watt tungsten lamp, which has a surface of approximately 1.61 dm², and the quantity of water vapor evolved amounted to 0.3 c.c. 0°/760 or about 2.41×10^{-4} grams. The weight of water is accordingly 1.5×10^{-4} grams per dm². If it is assumed that ammonia dissolves in the water film in the same manner as in liquid water, there would be 1.35×10^{-4} grams of ammonia adsorbed per dm². If ρ is the true density of the ammonia, v the volume of the globe in which it is proposed to measure the density of the ammonia, ω the weight of ammonia adsorbed per square dm. of surface, and s the surface of the globe, we may write:

Total weight of ammonia in the globe is $\rho V + \omega s = W$ or $\rho = \frac{W}{V} - \omega \frac{S}{V}$.

Let the subscript 1 denote a globe of radius r_1, and subscript 2 denote a second sphere of larger size and radius r_2, then $\frac{W_1}{V_1}$, the apparent density obtained in the first bulb, is equal to $\rho + \omega \frac{S_1}{V_1}$ and, similarly, $\frac{W_2}{V_2} = \rho + \omega \frac{S_2}{V_2}$.

If Δ is the difference in the measured densities,

$$\Delta = \frac{W_1}{V_1} - \frac{W_2}{V_2} = \left(\rho + \omega \frac{S_1}{V_1}\right) - \left(\rho + \omega \frac{S_2}{V_2}\right) = \omega\left(\frac{S_1}{V_1} - \frac{S_2}{V_2}\right) = 3\,\omega\left(\frac{1}{r_1} - \frac{1}{r_2}\right). \qquad (a)$$

The value of the density calculated by the equation of state is 0.76994, while the density found by Perman and Davies is 0.77085, the difference being 0.00091 gram. From the equation above,

$$\omega = \left(\frac{W}{V} - \rho\right)\frac{V}{S} = 0.00091\left(\frac{V}{S}\right).$$

Now for a liter sphere $r = 0.621$ dm². Since $\frac{V}{S} = \frac{1}{3}r$ or 0.207, $\omega = 0.000188$ gram per dm². The number obtained above by means of the Langmuir datum is of the same order of magnitude work was carried out with the greatest care and the average of two series of duplicate measurements at zero degrees and one atmosphere are in good agreement.

Measurements have been made by Dieterici* of the specific volumes of the vapor along the saturation curve. The measurements were made in

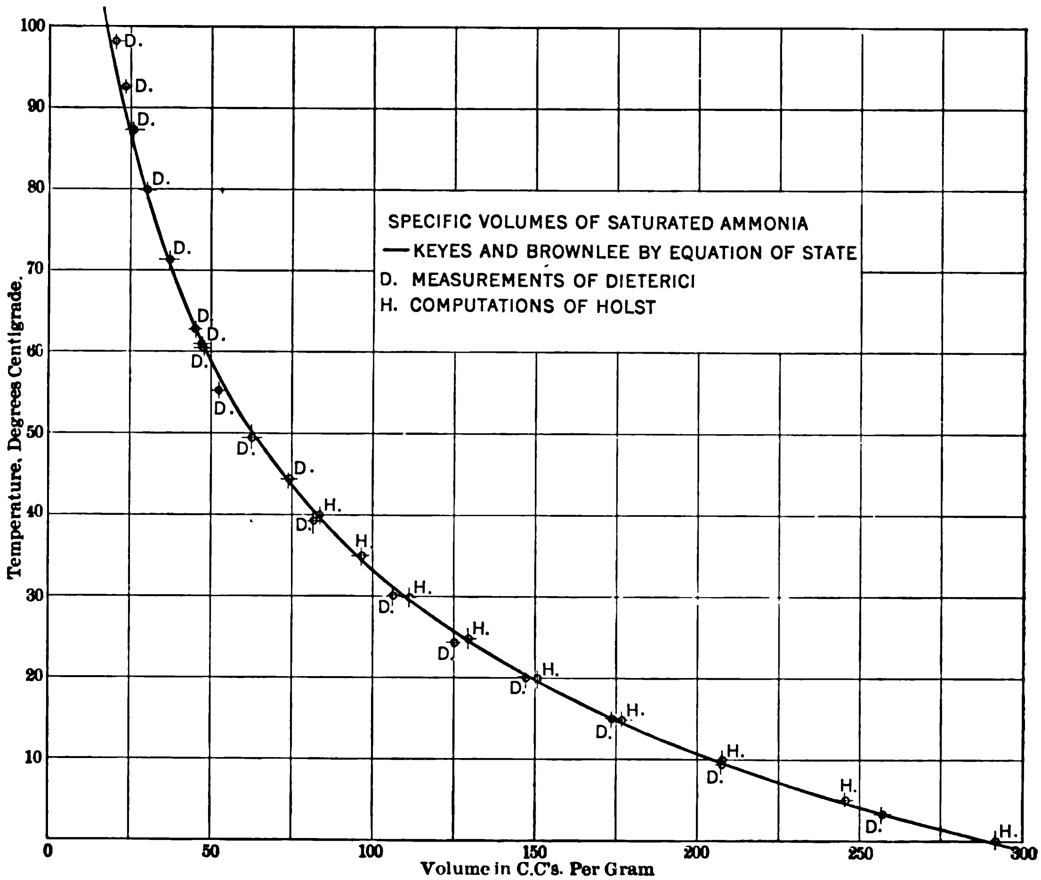

FIG. 5.

glass† and depend on the accuracy with which the liquid volumes are known. Holst has also computed by means of the Onnes virial equation

(0.000135). Applying the values to the two spheres used by Perman and Davies there results:

$$\left\{\begin{array}{l} \omega_L = 0.000135. \\ \omega_{P.D.} = 0.000188. \\ r_1 = 0.4925\,\text{dm}^2. \\ r_2 = 0.7510\,\text{dm}^2. \end{array}\right. \qquad \begin{array}{l} \Delta_{P.D.} = 3\,\omega_{P.D.}\left(\frac{r_2 - r_1}{r_1 r_2}\right) = +\,0.000327. \\ \Delta_L = 3\,\omega_L\left(\frac{r_2 - r_1}{r_1 r_2}\right) = +\,0.000235. \end{array}$$

The difference in the apparent densities therefore would amount to only about a quarter of a milligram. In view of the difficulties attending the accurate weighing of large globes it would appear that the detection of adsorption by varying the surface is not very sensitive at one atmosphere pressure and zero degrees.

* Dieterici, *Zeit. für die Desam. Kalte Industrie*, **21** (1904).

† Young, *Trans. Chem. Soc.*, **59**, 37, 126, 929 (1891).

the specific volumes of the saturated vapor,* the constants of the equation being based on the measurements of the vapor phase isotherms obtained at the Leiden Laboratory. The saturated specific volumes used in the present tables were computed by means of the equation of state (33). This computation requires the saturation pressures which were determined from the vapor-pressure equation (31). In Fig. 5 the full line is drawn through the computed saturation specific volumes while the experimental values of Dieterici are entered as indicated together with the values computed by Holst. The full line is a representative line through the Dieterici and Holst values up to about 70 degrees, when the Dieterici data assumes a distinctly different trend. The specific volumes of the liquid obtained by Dieterici on the other hand show a trend in the opposite direction.

7. THE HEAT OF VAPORIZATION OF LIQUID AMMONIA

Measurements involving the heat of vaporization of ammonia were made by Regnault, and of these measurements twelve† survived the reign of the Commune and were later published. A careful consideration of Regnault's data involving the heat of vaporization of liquid ammonia has been given by Jacobus and Denton.‡ Franklin and Kraus§ measured the quantity at the boiling point of liquid ammonia (−33.2), their value differing considerably from the value obtained by Estreicher and Schuerr.‖ The original communication containing the Estreicher and Schuerr measurements is not available and hence a critical examination of the method used or a review of the data used in making necessary corrections is precluded. The method pursued by Franklin and Kraus consisted in vaporizing a definite volume of liquid ammonia at atmospheric pressure by supplying heat electrically. The calculation of the heat of vaporization requires the electrical energy, the density of liquid ammonia at −33.2° C., and the value of the calorimetric equivalent of the joule at 15 degrees. The value of the electrochemical equivalent of copper used by Franklin and Kraus was retained in the recalculation. The recomputed mean of the Franklin and Kraus measurements using the latest density data and the 15 degree cal. employed in the present tables accordingly is 336.58 Cal. at −33.2 degrees. A confirmation of the general correctness of this value may be obtained from the data concerning the elevation of the boiling point of liquid ammonia. The data in this connection is also due to Franklin and Kraus.¶ The mean value of

* The Onnes equation reads:

$$pv = RT + \frac{a_1}{V} + \frac{a_2}{V^2} + \cdots$$

† *Ann. de Chim. et de Physique* (4) **24**, 375 (1871).

‡ Jacobus, *Trans. Am. Soc. Mech. Eng.*, **12**, 307 (1891).

§ *Jour. Phys. Chem.*, **2**, 555 (1907).

‖ *Acad. Soc. Cracovie, Bull.*, **7A**, 345 (1910).

¶ *Am. Chem. Jour.*, **20**, 841 (1898).

k in Van't Hoff's formula $\left(L = \frac{0.019885\ T^2}{k}\right)$, taken from the elevation of the boiling point where water and alcohol were used as solutes, is 3.398. The Van't Hoff formula leads to the value 336.8 Cal. as the heat of vaporization at −33.2 degrees. The value obtained by means of the Clapeyron-Clausius relation, $T\frac{dp}{dT}(v_1 - v_2) = L$, where the quantities on the left of the equation are obtained from the vapor-pressure equation (30), the equation of state (33), and the equation of the liquid volume, leads to the value 336.5 at −33.2 degrees.

The equation relating the heat of vaporization of liquid ammonia to the temperature depends on the heats of vaporization calculated by means of the Clapeyron-Clausius equation from the data obtained at the Research Laboratory. The value of L was computed at 80°, 40°, 0°, and at −70° C. The value of L at −70 degrees, on account of the uncertainty of the vapor-pressure equation at the lowest temperatures, cannot be considered to possess the same relative accuracy as the values of the heat of vaporization computed for the higher temperatures. The values calculated, however, at the temperatures mentioned were related to the temperature by means of a modified formula due to Thiesen. The Thiesen formula connecting the heat of vaporization with the temperature is $L = C\ (T_c - T)^n$, where c and n are constants and T_c the critical temperature. The equation satisfies the current ideas concerning the terminal conditions of the curve (L, T) — namely, it yields a finite value of the heat of vaporization at the absolute zero and a zero value at the critical temperature. Taking logarithms of both sides of the equation there results $\log L = \log C + n \log (T_c - T)$, consequently the logarithm of L is a linear function of the logarithm of $\log (T_c - T)$ and $\frac{d \log L}{d \log T} = n$. The equation was not found to hold strictly for liquid ammonia although it does satisfy the values very nearly. To modify the equation it was assumed that the differential could be expressed as $\frac{d \log L}{d \log T} = a + b\ (T_c - T)$. The resulting equation was then integrated, yielding the equation

$$\log_{10} L = 1.56817 - 2.822 \cdot 10^{-5}\ (T_c - T) + 0.43387 \log_{10} (T_c - T). \quad (34)$$

The values of L calculated by the latter equation together with the Regnault-Jacobus and Kraus values are given in Table 2.

Gilles Holst,* in a recent publication concerning the properties of ammonia, computed the heats of vaporization of liquid ammonia from Regnault's data, using the more accurate Dieterici specific heat values now available in computing the corrections. The average temperature of Regnault's twelve measurements is 11.68° C., and the rate of change of the heat of vaporization with temperature may be taken from equation

* Gilles Holst, *Les propriétés thermiques de l'ammoniaque et du Chlorure de méthyle, Leiden* (1914).

(34) to reduce each of Regnault's measurements to the average temperature. The result of this averaging is 295.7 Cal., whereas equation (34) leads to the value 294.3 Cal. at 11.68 degrees. The average Regnault value is accordingly 0.5 per cent higher than the value derived from the equation.

TABLE 2. VALUES OF HEAT OF VAPORIZATION L

Temperature	Calculated by equation (34)	Observed	Percentage difference	Observer
−33.4	336.7	321.3	−4.58	Estreicher and Schuerr
−33.2	336.5	336.6	+0.03	Franklin and Kraus measured
−33.2	336.5	336.8	+0.08	Franklin and Kraus from ebullioscopic constant
−23.71	328.1	316.1	−3.6	Regnault—Jacobus—Denton
−19.55	324.5	335.1	+3.2	
− 9.72	316.0	317.0	+0.3	
7.80	298.4	293.0	−1.8	Regnault—Jacobus
9.52	296.7	295.0	−0.6	
10.15	296.0	292.4	−1.2	
10.73	295.4	288.1	−2.5	
10.90	295.3	287.0	−2.8	
10.99	295.1	293.3	−0.6	
11.00	295.1	291.3	−1.3	
11.04	295.1	292.5	−0.9	
11.90	294.8	285.8	−2.9	
12.60	293.5	291.6	−0.6	
12.94	293.1	283.8	−3.1	
15.53	290.4	285.2	−1.8	
16.00	289.9	294.0	+1.4	
17.00	288.9	296.8	+2.7	
19.53	286.0	296.5	+3.7	
28.18	276.4	292.0	+5.8	Regnault—Jacobus—Denton
29.22	275.4	291.8	+5.3	
30.92	273.4	285.0	+4.2	

Holst in his summing up of the properties of ammonia has computed the heats of vaporization by means of the Clapeyron equation, using the specific volumes of the saturated vapor based on the Onnes "virial" equation of state and using values of $\frac{dp}{dT}$ derived from a careful study of Regnault's vapor-pressure measurements. Table 3 contains the Holst values compared with the values computed by means of equation (34).

TABLE 3

Temperature	Computed by Holst	Computed by equation (34)	Percentage difference
−40	328.5	341.98	−3.9
−30	322.5	333.62	−3.3
−20	316.0	324.86	−2.4
−10	309.0	315.74	−2.1
0	301.4	306.01	−1.5
+10	293.2	296.01	−0.9
+20	284.4	285.49	−0.4
+30	274.8	274.43	+0.14
+40	264.2	262.67	+0.67

Regnault's values of the vapor-pressure were perceived to be low by Holst, and it is now known that the corrections applied by Regnault to his mercury thermometer below zero were in error. This circumstance would make uncertain values of $\frac{dp}{dT}$ resulting from the vapor-pressure curve and also the values of L calculated by means of the Clapeyron equation. A glance at the Z diagram makes evident at once the erratic trend of the Regnault data.

Accurate experimental values of the heat of vaporization of liquid ammonia are necessary in the temperature interval between 0 degrees and 20 degrees; however, the Franklin-Kraus value at the boiling point and the mean Regnault value at 11.68 would indicate that equation (34) represents the heat of vaporization with substantial accuracy.

8. THE SPECIFIC HEAT-CAPACITY OF AMMONIA VAPOR

The measurements of the specific heat-capacity of ammonia have been reviewed by Nernst* and the results summarized in the equation:

$$C_{p,\,1\,\mathrm{atm.}} = 8.62 + 0.002\,t + 7.2 \cdot 10^{-7}\,t^3. \tag{35}$$

The equation gives the heat-capacity for one formula weight or 17.034 grams. The equation of state (33) applied in connection with the equation $C_v = C_p - T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{\partial v}{\partial T}\right)_p$ leads to the equation for C_v as follows:

$$C_v = 0.35116 + 1.055 \cdot 10^{-4}\,T + 6.05 \cdot 10^{-8}\,T^2. \tag{36}$$

Accordingly, the specific heat at constant pressure is given by the equation

$$C_p = 0.35116 + 1.055 \cdot 10^{-4}\,T + 6.05 \cdot 10^{-8}\,T^2 + \frac{R}{\left(1 - \frac{\alpha\delta}{v^2}\right) - \frac{2\,a}{RT}\frac{(v-\delta)^2}{(v-l)^3}}, \tag{37}$$

since $\left(\frac{\partial p}{\partial T}\right)_v = \frac{R}{(v-\delta)}$ and $\left(\frac{\partial v}{\partial T}\right)_p = \frac{v-\delta}{T}\left(\frac{1}{\left(1 - \frac{\alpha\delta}{v^2}\right) - \frac{2\,a}{RT}\frac{(v-\delta)^2}{(v-l)^3}}\right)$

The quantity $\int C_p\,dT$ or the integral heat along a constant pressure curve must be obtained by integrating graphically the term

$$\frac{R\,dT}{\left(1 - \frac{\alpha\delta}{v^2}\right) - \frac{2\,a}{RT}\frac{(v-\delta)^2}{(v-l)^3}}.$$

Fig. 6 gives a picture of the C_p field. At high temperatures and low pressures the equation (37) tends to resolve into $C_p = C_v + R$ as in fact the diagram illustrates.

* *Zeitschr. f. Electrochemie*, **16**, 96 (1910).

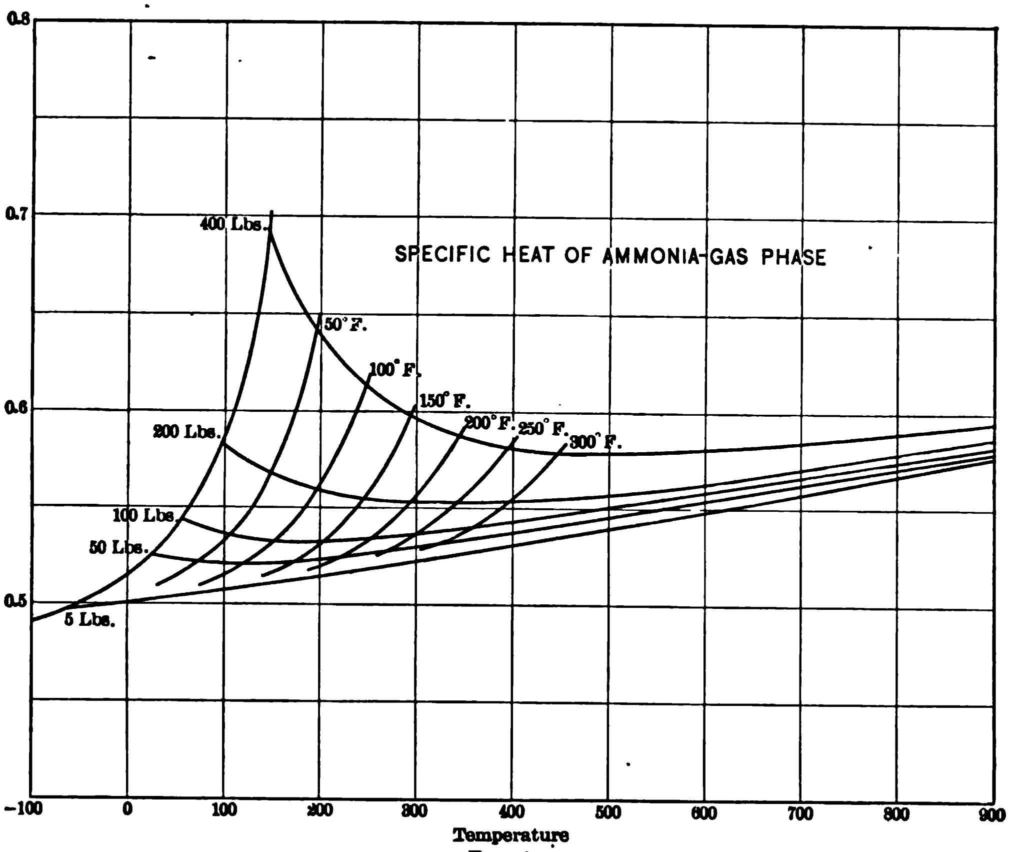

FIG. 6.

9. THE ENTROPY OF AMMONIA VAPOR

Equation (14) gives for the entropy $\Phi = \int \frac{C_v\,dt}{T} + R\int \frac{dv}{(v-\delta)} + \Phi_0$. The main difficulty that arises in the use of this equation is the integration of $\frac{dv}{v-\delta}$ which contains the transcendental δ. Up to the present time no integral has been found for this expression in terms of ordinary functions. One method, however, of integrating the function is as follows:

assume $$\int \frac{dv}{v-\delta} = \log(v-\delta) + \alpha\beta \int \frac{1}{v^2} \cdot \frac{e^{-\frac{\alpha}{v}}\,dv}{(v-\delta)}. \tag{38}$$

The problem now is reduced to the integration of the second term of the right-hand member, and since $d\frac{1}{v} = d\rho = -\frac{1}{v^2}\,dv$ it follows that

$$\alpha\beta \int \frac{\rho\,d\rho}{e^{\alpha\rho}} \cdot \frac{1}{1-\frac{\beta\rho}{e^{\alpha\rho}}} = \alpha\left[\int \frac{\beta\rho\,d\rho}{e^{\alpha\rho}} + \int \left(\frac{\beta\rho}{e^{\alpha\rho}}\right)^2 d\rho + \cdots + \int \left(\frac{\beta\rho}{e^{\alpha\rho}}\right)^n d\rho\right]. \tag{39}$$

It can be easily shown that the series part of (38) converges for all values of the variable ρ.

Let $e^{\alpha\rho} = z$, whence

$$\int \frac{\beta\rho}{e^{\alpha\rho}}\,d\rho = \frac{\beta}{\alpha^2}\int \frac{\log z}{z^2}\,dz,$$

and integrating this equation in z there results

$$\int \frac{(\log z)^n}{z^{n+1}}\,dz = -\left[\frac{1}{n}\left(\frac{\log z}{z}\right)^n + \frac{1}{n}\left(\frac{\log z}{z}\right)^{n-1}\frac{1}{z} + \frac{n-1}{n^2}\left(\frac{\log z}{z}\right)^{n-2}\frac{1}{z^2}\right.$$
$$\left. + \frac{(n-1)\,(n-2)}{n^3}\left(\frac{\log z}{z}\right)^{n-3}\frac{1}{z^3} + \cdots \text{ to } (n+1) \text{ terms.}\right] \qquad (40)$$

Applying (40) to each member of the series, collecting and rearranging, leads to the expression

$$\alpha\left[\int \frac{\beta\rho}{e^{\alpha\rho}}\,d\rho + \cdots\right] = \log\left(1 - \frac{\beta\rho}{e^{\alpha\rho}}\right) - \left\{\begin{array}{l} +\left(k + \frac{1}{2\cdot 2}k^2 + \cdots \frac{(n-1)!}{n^n}\cdot k^n\right), \\ p\left(\frac{1}{2}k + \frac{2!}{3\cdot 3}k^2 + \cdots + \frac{n!}{(n+1)^n}k^n\right) \\ +p^2\left(\frac{1}{3}k + \frac{1}{2!}\cdot\frac{3!}{4\cdot 4}k^2 + \cdots \right. \\ \qquad\left. + \frac{(n+1)!}{2!\,(n+2)^n}\cdot k^n\right) \\ + \cdots\cdots\cdots\cdots\cdots\cdots \\ +p^m\left(\frac{1}{m+1}k + \cdots \right. \\ \left. + \frac{1}{m!}\,\frac{(n+m-1)}{(n+m)^n}\,k^n\right) \end{array}\right.$$

$$= \sum f(\rho),$$

where $p = \frac{\beta}{\alpha}\cdot\frac{\log z}{z}$, $k = \frac{\beta}{\alpha}\cdot\frac{1}{z}$.

Table 4 represents the values of these series terms for various values of the density ρ of ammonia. In spite of the somewhat formidable appearance of the series portion of the integral it is seen that the series converge with such rapidity that the labor of calculating is not excessive. The computation of the series at 25 c.c., 50 c.c., 100 c.c., and 500 c.c. is sufficient, since beyond 500 c.c. the series gives a constant. In practice a plot of $\Sigma f(\rho)$ is most convenient. The complete expression for the entropy may be written as follows:

$$\Phi = 0.80859 \log_{10} T + 1.055\, T \cdot 10^{-4} + 3.025\, T^2 \cdot 10^{-8}$$
$$+ 0.2688 \log_{10}(v - \delta) + R\Sigma f(\rho) + \Phi_0. \qquad (41)$$

For volumes greater than 200 c.c. per gram $R\Sigma f(\rho)$ may with sufficient accuracy be assured constant.

TABLE 4

$\rho=0.05$	$\rho=0.02$	$\rho=0.01$	$\rho=0.002$	$\rho=0.001$	$\rho=0.0002$	Series Equation Above
1.26177	1.70690	1.9020	2.0802	2.1057	2.1241	k series
0.27012	0.02732	0.00935	0.00042	0.00011	....	p series
0.07114	0.00407	0.00077	0.00001	....	....	p^2 series
0.02026	0.00063	0.00006	....	....	....	p^3 series
0.00608	0.00010	....	....	....	....	p^4 series
0.00182	....	....	....	....	....	p^5 series
0.00055	....	....	....	....	....	p^6 series
0.00016	0.19587	0.12140	0.02904	0.01465	0.00297	p^7 series
0.40939	0.18182	0.09344	0.01909	0.00956	0.00192	$\log\left(1-\frac{\beta p}{e^{\alpha p}}\right)$
2.04122	2.11671	2.12702	2.12876	2.12902	....	$\Sigma f(\rho)$

10. THE SPECIFIC HEAT-CAPACITY OF LIQUID AMMONIA

In carrying out accurate heat-capacity measurements by the method of mixtures, it is necessary to have a large difference of temperature between the thermostat and the calorimeter, in order that the resulting temperature-change may be sufficiently large to permit the necessary percentage accuracy. There is considerable difficulty involved in obtaining the precise value for the water-equivalent of the calorimeter, and also in obtaining the value of the specific heat of the steel container or other receptacle containing the ammonia to be experimented on.

The following method of measuring heat-capacities was suggested by Dr. Charles A. Kraus of the Research Laboratory. A steel bomb containing liquid ammonia under the pressure of its saturated vapor is brought to a constant temperature in a thermostat above the calorimeter; it is then dropped into a calorimeter containing a definite weight of water, and the temperature-change of the calorimeter is observed. Another steel bomb identical with the first, but containing water under the pressure of its saturated vapor, is placed in the thermostat and dropped into the calorimeter. The weight of water in the water bomb is adjusted by repeated experiments until it gives practically the same temperature-change as the ammonia bomb. Omitting corrections, the specific heat-capacity of the ammonia would vary as the ratio of the weight of water to the weight of ammonia multiplied by the heat-capacity of the water.

This method does away with many of the objections to the method of mixtures. It is, of course, dependent for operation on a large temperature-difference between the thermostat and the calorimeter, but the errors are the same or nearly the same for both the ammonia and the water experiments and consequently compensate.

Mr. Henry A. Babcock after having completed the measurements of the specific heat-capacity by the method already outlined undertook the development of a method which would permit the measurement of the heat-capacity over very small temperature intervals and at various temperatures approaching the critical temperature. The method consisted essentially in rotating a steel ammonia container submerged in oil in a silvered Dewar tube. Measured amounts of electrical energy were introduced by means of a combined platinum resistance heater and thermometer. The amount of energy necessary to heat the oil and container was determined at a number of intervals between 20 and 120 degrees. The electrical energy necessary to raise the apparatus through one degree with the ammonia present was then obtained. The heat capacity of the

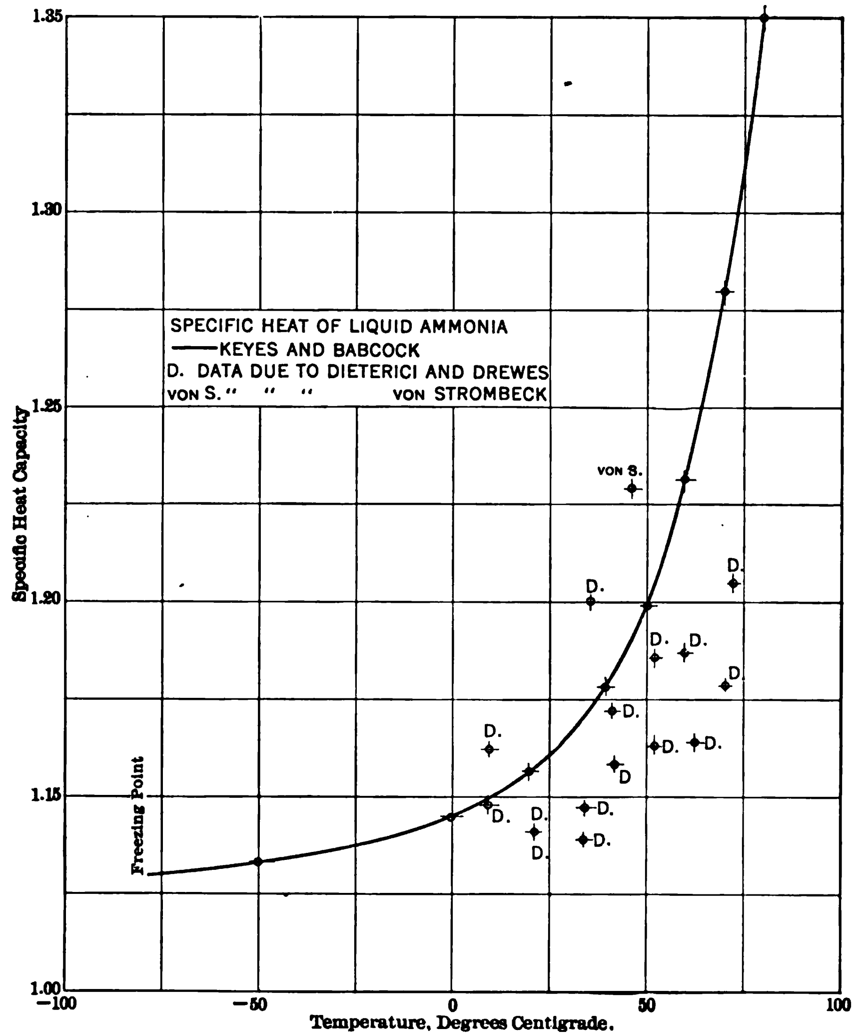

FIG. 7.

ammonia, after making the necessary corrections, is thus the difference between the two series of measurements at corresponding temperatures. These latter measurements have not been included in the equation used in the present tables, since the two more accurate values obtained by Mr. Babcock cover the practical range of temperature required in engineering work.

The equation taken to represent the saturation liquid specific heat-capacity is somewhat arbitrary. It seems probable that the heat-capacity, because of the term $\frac{dv}{dT}$, becomes infinite at the critical temperature. For this reason the empirical equation chosen to represent the heat capacity was

$$C_{s_1} = 1.13747 - \frac{5.7575}{(T_c - T)} + \frac{898.53}{(T_c - T)^2}. \qquad (42)$$

This equation passes through the two measurements made by Mr. Babcock. The course of the values is illustrated by Fig. 7 in which have been inserted the values reported by Dieterici. The equation for the integral heat referred to 0° C. is

$$\int_{273.1}^{T} C_{s_1} dT = 1.13747\, T + 13.257 \log_{10}(T_c - T) + \frac{898.53}{T_c - T} - 345.556. \qquad (43)$$

Table 5 gives a list of values as smoothed by Dieterici and reported in the "Landolt and Bornstein Tabellen." The Dieterici or Drewes values should be increased by about one per cent because of the calorie in which the results are expressed. The values given by other observers are also included for comparison.

TABLE 5. SPECIFIC HEAT-CAPACITY OF LIQUID AMMONIA

Drewes	0° C.	0.876	1.1450
Drewes	10	1.140	1.1501
Elleau & Ennis	10	1.02	1.1501
Drewes	20	1.19	1.1570
Ludeking & Starr	28	0.886	1.1642
Drewes	30	1.218	1.1664
Drewes	40	1.231	1.1796
von Strombeck	45	1.229	1.1883
Drewes	50	1.239	1.1988
Drewes	60	1.240	1.2275

PART II

TABLES OF THE THERMODYNAMIC CONSTANTS OF AMMONIA

DESCRIPTION OF THE TABLES

Table I gives the thermodynamic properties of saturated ammonia with the temperature as the argument, while Table II gives the properties with the pressure as the argument. The lower limit of the temperature table is -100° F.; the values being tabulated for each degree to 150° and to 200° for each five degrees.

The pressure table (Table II) is complete for every pound pressure from five to two hundred pounds pressure, from two hundred pounds for every two pounds to three hundred pounds pressure, for every ten pounds to five hundred pounds pressure, and for every twenty-five pounds to seven hundred pounds pressure.

The superheat table (Table III) gives the temperature, the total heat of the liquid, the vapor volume of liquid and vapor, and the entropies of the liquid and vapor corresponding from the saturation pressure to four hundred pounds. The total heat, the volume of the vapor and the entropy of the vapor is extended into the superheat three hundred degrees, every ten degrees of superheat being tabulated to two hundred degrees and every fifty degrees from two hundred degrees to three hundred degrees superheat.

In calculating the various quantities appearing in the tables large graphs were constructed from the values calculated from the equations already discussed. The vapor pressures were calculated corresponding to each 18° F. interval using equation (30). A check on the values tabulated from the graphs was subsequently obtained by calculating the pressure at temperatures nine degrees from the pressures which served to construct the graph.

The heat of the liquid was obtained by calculating the values needed for the graph from equation (43). This equation is obtained by integrating equation (42) with respect to the temperature. The values of entropy of the liquid are given by the equation which results from the integration of (42), after first dividing by the temperature. A general check on the values obtained by the method outlined was subsequently obtained by calculating the rates of change of the quantities from the corresponding equations which result by differentiation with respect to the temperature and comparing these calculated rates of change with the successive differences of the tabulated quantities.

The volumes at constant superheat (Table III) were calculated at suitable intervals from equation (33) and their reciprocal, or the density plotted against the saturation pressure. The resulting graph is nearly a straight line which greatly facilitated the reading of the densities. The densities were afterward converted into volumes by means of a table of reciprocals.

The total heat was obtained by graphically integrating the graph of the specific heat-capacity of the vapor plotted against the temperature and adding the quantities so found to the total heat of the saturated vapor. The graph of the entropy of the vapor was calculated from equation (41).

The consistence of the superheat table was checked by applying the equation $\left(\frac{\partial \phi}{\partial T}\right)_p = \frac{C_p}{T}$ in the following manner: Values of C_p were calculated for the vapor and compared with the differences in the total heat quantities at constant pressure. These values divided by the average absolute temperature were then compared with the differences in the tabulated entropy at constant pressure.

The Mollier Chart. — The solution of many refrigeration problems is greatly facilitated by the use of the usual heat content-entropy or Mollier diagram. The diagram accompanying the tables, I, II, and III, has curves at constant pressure, curves at constant quality, and constant temperature. The ordinates are heat contents and the abscissæ are entropies.

To bring the diagram into convenient compass oblique coördinates have been used. The horizontal lines are lines of constant heat content. The oblique lines are inclined at an angle of thirty degrees to the horizontal axis. Attention is directed to the fact that twice the vertical distances are equal to distances along the oblique lines.

TEMPERATURE

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
−100	1.132	196.9	0.00508	....	663.4	....	621.7	....	....	1.8437	....
− 95	1.408	161.5	.00619	....	659.6	....	617.3	....	....	1.8094	....
− 90	1.740	132.1	.00757	....	655.8	....	612.9	....	....	1.7750	....
− 85	2.134	109.1	.00917	....	652.0	....	608.4	....	....	1.7415	....
− 80	2.595	90.9	.01100	....	648.1	....	603.9	....	....	1.7086	....
− 75	3.108	76.16	0.01313	....	644.2	....	599.4	....	....	1.6765	....
− 70	3.780	64.20	.01558	....	640.3	....	594.9	....	....	1.6452	....
− 65	4.533	54.20	.01834	....	636.3	....	590.4	....	....	1.6142	....
− 60	5.378	46.09	.02170	....	632.3	....	585.9	....	....	1.5842	....
− 55	6.373	39.50	.02532	....	628.3	....	581.3	....	....	1.5547	....
− 50	7.513	33.90	0.02950	−93.2	624.2	531.0	576.8	483.6	−0.2076	1.5247	1.3171
− 49	7.761	32.87	.03042	−92.1	623.4	531.3	575.8	483.8	− .2048	1.5189	1.3141
− 48	8.014	31.89	.03136	−90.9	622.5	531.6	574.9	484.0	− .2020	1.5132	1.3112
− 47	8.272	30.97	.03229	−89.8	621.7	531.9	574.0	484.2	− .1992	1.5075	1.3083
− 46	8.541	30.09	.03323	−88.6	620.9	532.3	573.0	484.4	− .1965	1.5019	1.3054
− 45	8.810	29.24	0.03420	−87.5	620.1	532.6	572.1	484.6	−0.1938	1.4963	1.3025
− 44	9.088	28.42	.03519	−86.4	619.3	532.9	571.2	484.8	− .1911	1.4907	1.2996
− 43	9.377	27.62	.03621	−85.2	618.4	533.2	570.2	485.0	− .1884	1.4851	1.2967
− 42	9.675	26.84	.03726	−84.0	617.5	533.5	569.3	485.2	− .1857	1.4795	1.2938
− 41	9.974	26.09	.03833	−82.9	616.7	533.8	568.4	485.4	− .1830	1.4740	1.2910
− 40	10.282	25.36	0.03943	−81.8	615.9	534.1	567.4	485.6	−0.1803	1.4685	1.2882
− 39	10.600	24.65	.04057	−80.7	615.1	534.4	566.5	485.8	− .1776	1.4630	1.2854
− 38	10.930	23.97	.04172	−79.6	614.3	534.7	565.6	486.0	− .1749	1.4575	1.2826
− 37	11.261	23.31	.04290	−78.4	613.4	535.0	564.6	486.2	− .1722	1.4521	1.2799
− 36	11.601	22.67	.04411	−77.3	612.6	535.3	563.7	486.4	− .1695	1.4467	1.2772
− 35	11.952	22.06	0.04533	−76.2	611.7	535.6	562.8	486.6	−0.1668	1.4413	1.2745
− 34	12.312	21.47	.04658	−75.0	610.9	535.9	561.8	486.8	− .1641	1.4359	1.2718
− 33	12.682	20.89	.04787	−73.9	610.1	536.2	560.9	487.0	− .1614	1.4305	1.2691
− 32	13.056	20.33	.04919	−72.8	609.2	536.4	560.0	487.2	− .1588	1.4252	1.2664
− 31	13.439	19.79	.05053	−71.6	608.3	536.7	559.0	487.4	− .1561	1.4199	1.2638

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy B.t.u. Evap.	Internal energy B.t.u. Vapor	Entropy Liquid	Entropy Evap.	Entropy Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
−30	13.830	19.27	0.05189	−70.5	607.5	537.0	558.1	487.6	−0.1535	1.4146	1.2611
−29	14.232	18.77	.05328	−69.3	606.6	537.3	557.2	487.8	− .1509	1.4093	1.2584
−28	14.645	18.28	.05470	−68.2	605.8	537.6	556.2	488.0	− .1482	1.4040	1.2558
−27	15.067	17.80	.05618	−67.0	604.9	537.9	555.2	488.2	− .1455	1.3987	1.2532
−26	15.499	17.33	.05770	−65.9	604.1	538.2	554.3	488.4	− .1429	1.3935	1.2506
−25	15.940	16.88	0.05924	−64.8	603.2	538.4	553.3	488.6	−0.1403	1.3883	1.2480
−24	16.391	16.45	.06080	−63.6	602.3	538.7	552.4	488.8	− .1376	1.3831	1.2455
−23	16.853	16.03	.06238	−62.5	601.5	539.0	551.5	489.0	− .1350	1.3779	1.2429
−22	17.326	15.62	.06402	−61.3	600.6	539.2	550.5	489.2	− .1324	1.3727	1.2403
−21	17.810	15.22	.06570	−60.2	599.7	539.5	549.6	489.4	− .1298	1.3676	1.2378
−20	18.304	14.84	0.06738	−59.1	598.9	539.8	548.6	489.5	−0.1272	1.3625	1.2353
−19	18.808	14.47	.06910	−58.0	598.0	540.0	547.6	489.6	− .1246	1.3574	1.2328
−18	19.320	14.11	.07087	−56.9	597.1	540.2	546.7	489.8	− .1221	1.3523	1.2302
−17	19.840	13.76	.07267	−55.7	596.2	540.5	545.7	490.0	− .1195	1.3472	1.2277
−16	20.371	13.43	.07446	−54.6	595.4	540.8	544.8	490.2	− .1169	1.3422	1.2253
−15	20.912	13.11	0.07628	−53.5	594.5	541.0	543.8	490.3	−0.1144	1.3372	1.2228
−14	21.465	12.79	.07819	−52.3	593.6	541.3	542.8	490.5	− .1119	1.3322	1.2203
−13	22.037	12.48	.08013	−51.2	592.7	541.5	541.9	490.7	− .1093	1.3272	1.2179
−12	22.619	12.18	.08210	−50.0	591.8	541.8	540.9	490.9	− .1068	1.3222	1.2154
−11	23.210	11.89	.08410	−48.9	590.9	542.0	539.9	491.0	− .1042	1.3172	1.2130
−10	23.810	11.60	0.08620	−47.8	590.1	542.3	538.9	491.1	−0.1017	1.3123	1.2106
−9	24.420	11.32	.08834	−46.7	589.2	542.5	537.9	491.2	− .0993	1.3075	1.2082
−8	25.052	11.05	.09050	−45.6	588.3	542.7	537.0	491.4	− .0968	1.3026	1.2058
−7	25.693	10.79	.09259	−44.4	587.4	543.0	536.0	491.6	− .0943	1.2977	1.2034
−6	26.352	10.54	.09479	−43.3	586.5	543.2	535.1	491.8	− .0918	1.2928	1.2010
−5	27.027	10.30	0.09709	−42.1	585.6	543.5	534.1	492.0	−0.0893	1.2880	1.1987
−4	27.710	10.06	.09940	−41.0	584.7	543.7	533.1	492.1	− .0868	1.2831	1.1963
−3	28.41	9.84	.1016	−39.8	583.8	544.0	532.1	492.3	− .0843	1.2783	1.1940
−2	29.12	9.61	.1040	−38.7	582.9	544.2	531.2	492.5	− .0818	1.2735	1.1917
−1	29.84	9.39	.1065	−37.6	582.0	544.4	530.2	492.6	− .0793	1.2687	1.1894

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u. Evap.	Internal energy, B.t.u. Vapor	Entropy Liquid	Entropy Evap.	Entropy Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
0	30.57	9.18	0.1089	−36.5	581.1	544.6	529.2	492.7	−0.0768	1.2640	1.1872
+1	31.33	8.97	.1115	−35.3	580.1	544.8	528.2	492.9	− .0743	1.2593	1.1850
2	32.09	8.77	.1129	−34.2	579.2	545.0	527.2	493.0	− .0718	1.2546	1.1828
3	32.87	8.58	.1165	−33.0	578.3	545.3	526.2	493.2	− .0693	1.2500	1.1807
4	33.66	8.39	.1192	−31.9	577.4	545.5	525.3	493.4	− .0669	1.2454	1.1785
5	34.47	8.20	0.1220	−30.8	576.5	545.7	524.3	493.5	−0.0644	1.2407	1.1763
6	35.29	8.02	.1247	−29.7	575.6	545.9	523.3	493.6	− .0619	1.2360	1.1741
7	36.14	7.84	.1275	−28.5	574.6	546.1	522.3	493.8	− .0595	1.2314	1.1719
8	37.00	7.67	.1304	−27.4	573.7	546.3	521.4	494.0	− .0570	1.2267	1.1697
9	37.87	7.51	.1333	−26.2	572.8	546.6	520.4	494.2	− .0546	1.2221	1.1675
10	38.76	7.35	0.1360	−25.1	571.9	546.8	519.4	494.3	−0.0522	1.2176	1.1654
11	39.68	7.19	.1391	−24.0	571.0	547.0	518.4	494.4	− .0498	1.2130	1.1632
12	40.61	7.03	.1422	−22.8	570.0	547.2	517.4	494.6	− .0474	1.2084	1.1610
13	41.54	6.88	.1453	−21.7	569.1	547.4	516.4	494.7	− .0450	1.2039	1.1589
14	42.49	6.73	.1486	−20.6	568.2	547.6	515.4	494.8	− .0426	1.1994	1.1568
15	43.47	6.594	0.1516	−19.4	567.2	547.8	514.4	495.0	−0.0402	1.1949	1.1547
16	44.45	6.456	.1549	−18.3	566.2	547.9	513.4	495.1	− .0378	1.1905	1.1527
17	45.46	6.320	.1582	−17.2	565.3	548.1	512.4	495.2	− .0354	1.1860	1.1506
18	46.50	6.189	.1616	−16.0	564.3	548.3	511.4	495.4	− .0331	1.1815	1.1484
19	47.54	6.061	.1650	−14.8	563.3	548.5	510.4	495.5	− .0307	1.1770	1.1463
20	48.60	5.934	0.1685	−13.7	562.4	548.6	509.4	495.6	−0.0283	1.1725	1.1442
21	49.68	5.811	.1721	−12.6	561.5	548.8	508.4	495.7	− .0259	1.1681	1.1422
22	50.78	5.691	.1757	−11.4	560.5	549.1	507.3	495.9	− .0235	1.1637	1.1401
23	51.90	5.576	.1793	−10.3	559.6	549.3	506.3	496.0	− .0212	1.1593	1.1381
24	53.03	5.463	.1830	− 9.2	558.7	549.5	505.3	496.1	− .0188	1.1549	1.1361
25	54.19	5.352	0.1868	− 8.1	557.8	549.7	504.3	496.2	−0.0165	1.1505	1.1340
26	55.37	5.245	.1906	− 6.9	556.8	549.9	503.2	496.3	− .0141	1.1461	1.1320
27	56.57	5.139	.1946	− 5.7	555.8	550.1	502.2	496.5	− .0117	1.1417	1.1300
28	57.79	5.037	.1985	− 4.6	554.8	550.2	501.2	496.6	− .0094	1.1374	1.1280
29	59.03	4.936	.2026	− 3.5	553.9	550.4	500.2	496.7	− .0071	1.1331	1.1260

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
30	60.29	4.838	0.2067	− 2.3	552.8	550.5	499.2	496.9	−0.0047	1.1288	1.1241
31	61.57	4.743	.2108	− 1.2	551.9	550.7	498.1	496.9	− .0023	1.1245	1.1222
32	62.86	4.650	.2151	+ 0.0	550.9	550.9	497.1	497.1	+ .0000	1.1202	1.1202
33	64.17	4.559	.2193	1.1	549.9	551.0	496.2	497.3	.0023	1.1160	1.1183
34	65.51	4.469	.2238	2.2	549.0	551.2	495.1	497.3	.0047	1.1117	1.1164
35	66.87	4.382	0.2281	3.4	547.9	551.3	494.1	497.5	0.0070	1.1075	1.1145
36	68.26	4.298	.2327	4.5	547.0	551.5	493.1	497.6	.0093	1.1033	1.1126
37	69.66	4.216	.2372	5.6	546.0	551.6	492.0	497.6	.0116	1.0991	1.1107
38	71.08	4.135	.2418	6.8	545.0	551.8	491.0	497.8	.0139	1.0949	1.1088
39	72.54	4.056	.2465	8.0	543.9	551.9	490.0	498.0	.0161	1.0907	1.1068
40	74.01	3.979	0.2513	9.2	542.9	552.1	488.9	498.1	0.0184	1.0865	1.1049
41	75.51	3.904	.2561	10.3	542.0	552.3	487.8	498.1	.0207	1.0823	1.1030
42	77.03	3.830	.2611	11.5	541.0	552.5	486.7	498.2	.0230	1.0781	1.1011
43	78.57	3.758	.2661	12.6	540.0	552.6	485.7	498.3	.0253	1.0740	1.0993
44	80.14	3.688	.2711	13.7	539.0	552.7	484.7	498.4	.0276	1.0699	1.0975
45	81.73	3.619	0.2763	14.9	537.9	552.8	483.6	498.5	0.0298	1.0658	1.0956
46	83.35	3.552	.2815	16.0	537.0	553.0	482.6	498.6	.0321	1.0617	1.0938
47	84.99	3.486	.2869	17.2	535.9	553.1	481.5	498.7	.0344	1.0576	1.0920
48	86.65	3.422	.2922	18.3	534.9	553.2	480.5	498.8	.0366	1.0535	1.0902
49	88.33	3.359	.2977	19.5	533.8	553.3	479.5	499.0	.0389	1.0495	1.0884
50	90.04	3.298	0.3032	20.7	532.8	553.5	478.4	499.1	0.0412	1.0454	1.0866
51	91.77	3.239	.3087	21.8	531.8	553.7	477.3	499.2	.0434	1.0414	1.0848
52	93.53	3.181	.3144	23.0	530.8	553.8	476.3	499.3	.0457	1.0374	1.0830
53	95.30	3.124	.3201	24.1	529.8	553.9	475.3	499.4	.0479	1.0333	1.0812
54	97.10	3.067	.3259	25.3	528.7	554.0	474.2	499.5	.0502	1.0292	1.0794
55	98.93	3.011	0.3321	26.4	527.7	554.1	473.1	499.5	0.0524	1.0252	1.0776
56	100.79	2.957	.3382	27.5	526.7	554.2	472.0	499.5	.0547	1.0212	1.0759
57	102.68	2.904	.3444	28.7	525.6	554.3	470.9	499.6	.0569	1.0172	1.0741
58	104.60	2.852	.3506	29.9	524.5	554.4	469.9	499.8	.0592	1.0132	1.0724
59	106.55	2.802	.3569	31.0	523.5	554.5	468.8	499.8	.0614	1.0092	1.0706

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
60	108.54	2.752	0.3633	+32.2	522.4	554.6	467.7	499.9	+0.0636	1.0052	1.0688
61	110.53	2.704	.3698	33.3	521.4	554.7	466.6	499.9	.0659	1.0012	1.0671
62	112.51	2.657	.3764	34.5	520.3	554.8	465.5	500.0	.0681	.9973	1.0654
63	114.60	2.610	.3831	35.6	519.3	554.9	464.4	500.0	.0703	.9934	1.0637
64	116.7	2.564	.3900	36.7	518.2	554.9	463.4	500.1	.0725	.9895	1.0620
65	118.9	2.520	0.3968	37.9	517.1	555.0	462.3	500.2	0.0747	0.9856	1.0603
66	121.1	2.477	.4037	39.0	516.0	555.1	461.3	500.3	.0769	.9817	1.0586
67	123.3	2.434	.4108	40.2	514.9	555.1	460.2	500.4	.0791	.9778	1.0569
68	125.4	2.393	.4179	41.4	513.8	555.2	459.1	500.5	.0813	.9739	1.0552
69	127.6	2.352	.4252	42.6	512.7	555.3	458.0	500.6	.0835	.9700	1.0535
70	129.9	2.311	0.4327	43.8	511.6	555.4	456.9	500.7	.0857	0.9661	1.0518
71	132.2	2.272	.4401	44.9	510.5	555.4	455.8	500.7	.0879	.9622	1.0501
72	134.6	2.233	.4478	46.1	509.4	555.5	454.7	500.8	.0901	.9583	1.0484
73	136.9	2.196	.4554	47.2	508.3	555.5	453.6	500.8	.0923	.9544	1.0467
74	139.3	2.159	.4632	48.4	507.2	555.6	452.5	500.9	.0944	.9506	1.0450
75	141.7	2.123	0.4710	49.5	506.1	555.6	451.4	500.9	.0966	0.9468	1.0434
76	144.2	2.087	.4792	50.7	505.0	555.7	450.3	501.0	.0988	.9430	1.0418
77	146.7	2.052	.4873	51.9	503.9	555.8	449.1	501.0	.1010	.9392	1.0402
78	149.2	2.018	.4955	53.1	502.8	555.9	448.0	501.1	.1032	.9354	1.0386
79	151.8	1.984	.5040	54.2	501.7	555.9	446.9	501.1	.1054	.9316	1.0370
80	154.4	1.952	0.5123	55.4	500.6	556.0	445.8	501.2	0.1075	0.9278	1.0353
81	157.0	1.920	.5208	56.6	499.5	556.1	444.7	501.3	.1097	.9240	1.0337
82	159.6	1.889	.5294	57.7	498.4	556.1	443.6	501.3	.1119	.9202	1.0321
83	162.3	1.859	.5379	58.9	497.3	556.2	442.5	501.4	.1141	.9164	1.0305
84	165.0	1.829	.5470	60.0	496.2	556.3	441.4	501.4	.1163	.9126	1.0289

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
85	167.8	1.799	0.5559	61.2	495.1	556.3	440.2	501.4	0.1184	0.9088	1.0272
86	170.5	1.770	.5650	62.4	494.0	556.4	439.1	501.5	.1206	.9050	1.0256
87	173.3	1.742	.5744	63.6	492.8	556.4	437.9	501.5	.1227	.9013	1.0240
88	176.2	1.714	.5834	64.8	491.7	556.5	436.7	501.5	.1249	.8976	1.0225
89	179.1	1.687	.5928	66.0	490.5	556.5	435.6	501.6	.1270	.8939	1.0209
90	182.0	1.660	0.6028	67.1	489.4	556.5	434.5	501.6	0.1291	0.8902	1.0193
91	185.0	1.633	.6124	68.3	488.2	556.5	433.3	501.6	.1312	.8865	1.0177
92	188.0	1.607	.6223	69.5	487.0	556.5	432.2	501.7	.1333	.8828	1.0161
93	191.0	1.581	.6325	70.7	485.9	556.6	431.0	501.7	.1354	.8789	1.0143
94	194.1	1.556	.6427	71.9	484.7	556.6	429.8	501.7	.1375	.8752	1.0127
95	197.2	1.532	0.6527	73.1	483.5	556.6	428.7	501.8	0.1396	0.8715	1.0111
96	200.4	1.508	.6636	74.2	482.4	556.6	427.6	501.8	.1417	.8678	1.0095
97	203.6	1.484	.6739	75.4	481.2	556.6	426.4	501.8	.1438	.8641	1.0079
98	206.9	1.461	.6845	76.6	480.0	556.6	425.2	501.8	.1459	.8605	1.0064
99	210.1	1.437	.6959	77.7	478.8	556.5	424.1	501.8	.1480	.8569	1.0049
100	213.4	1.414	0.707	78.9	477.6	556.5	422.9	501.8	0.1500	0.8533	1.0033
101	216.7	1.392	.718	80.0	476.5	556.5	421.8	501.8	.1521	.8497	1.0018
102	220.1	1.370	.730	81.2	475.3	556.5	420.6	501.8	.1542	.8461	1.0003
103	223.5	1.350	.741	82.4	474.1	556.5	419.4	501.8	.1563	.8425	.9988
104	226.9	1.330	.752	83.6	472.9	556.5	418.2	501.8	.1584	.8389	.9973
105	230.4	1.310	0.763	84.7	471.7	556.4	417.1	501.8	0.1605	0.8353	0.9958
106	233.9	1.290	.776	85.9	470.5	556.4	415.9	501.8	.1625	.8317	.9942
107	237.4	1.270	.787	87.1	469.2	556.3	414.7	501.8	.1646	.8281	.9927
108	241.0	1.251	.799	88.3	468.0	556.3	413.5	501.8	.1666	.8245	.9911
109	244.7	1.232	.812	89.4	466.8	556.2	412.3	501.7	.1687	.8209	.9896

TEMPERATURE. — *Continued*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
110	248.4	1.213	0.824	90.6	465.5	556.1	411.1	501.7	0.1708	0.8173	0.9881
111	252.1	1.195	.837	91.7	464.3	556.0	410.0	501.7	.1729	.8137	.9866
112	255.9	1.176	.850	92.9	463.0	555.9	408.8	501.7	.1749	.8101	.9850
113	259.8	1.158	.864	94.1	461.8	555.9	407.5	501.6	.1770	.8065	.9835
114	263.7	1.141	.876	95.3	460.5	555.8	406.3	501.6	.1790	.8029	.9819
115	267.6	1.123	0.891	96.5	459.2	555.7	405.1	501.6	0.1811	0.7993	0.9804
116	271.6	1.106	.904	97.7	457.9	555.6	403.9	501.6	.1832	.7957	.9789
117	275.6	1.089	.918	98.9	456.6	555.5	402.6	501.5	.1853	.7921	.9774
118	279.6	1.073	.933	100.1	455.4	555.5	401.4	501.5	.1874	.7885	.9759
119	283.7	1.057	.946	101.2	454.1	555.3	400.1	501.3	.1895	.7849	.9744
120	287.9	1.042	0.960	102.4	452.9	555.3	398.8	501.2	0.1916	0.7813	0.9729
121	292.1	1.026	.975	103.6	451.6	555.2	397.6	501.2	.1937	.7777	.9714
122	296.3	1.011	.989	104.8	450.3	555.1	396.4	501.2	.1957	.7741	.9698
123	300.5	0.996	1.004	106.0	449.0	555.0	395.2	501.2	.1978	.7705	.9683
124	304.8	.982	1.018	107.2	447.7	554.9	393.9	501.1	.1998	.7669	.9667
125	309.2	0.968	1.033	108.4	446.4	554.8	392.7	501.1	0.2019	0.7633	0.9652
126	313.6	.954	1.048	109.6	445.1	554.7	391.4	501.0	.2040	.7597	.9637
127	318.0	.940	1.065	110.8	443.8	554.6	390.2	501.0	.2060	.7561	.9621
128	322.5	.926	1.080	112.0	442.5	554.5	388.9	500.9	.2081	.7525	.9606
129	327.1	.913	1.095	113.3	441.1	554.4	387.6	500.9	.2102	.7490	.9592
130	331.7	0.899	1.112	114.5	439.8	554.3	386.4	500.9	0.2123	0.7454	0.9577
131	336.4	.886	1.129	115.7	438.5	554.2	385.1	500.8	.2144	.7418	.9562
132	341.1	.873	1.145	116.9	437.2	554.1	383.8	500.7	.2165	.7382	.9547
133	345.8	.860	1.163	118.1	435.8	553.9	382.5	500.6	.2185	.7347	.9532
134	350.6	.848	1.180	119.4	434.4	553.8	381.2	500.6	.2205	.7312	.9517

TEMPERATURE. — *Concluded*

Temp. °F.	Pressure, lb. per sq. in.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of evap.	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
t	p	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
135	355.5	0.836	1.196	120.6	433.1	553.7	379.9	500.5	0.2226	0.7277	0.9503
136	360.4	.824	1.214	121.8	431.7	553.5	378.6	500.4	.2247	.7242	.9489
137	365.4	.812	1.233	123.0	430.3	553.3	377.3	500.3	.2267	.7207	.9474
138	370.4	.800	1.252	124.2	428.9	553.1	376.0	500.2	.2287	.7172	.9459
139	375.4	.788	1.269	125.4	427.6	553.0	374.7	500.1	.2308	.7137	.9445
140	380.6	0.777	1.287	126.6	426.2	552.8	373.4	500.0	0.2328	0.7102	0.9430
141	385.7	.765	1.307	127.8	424.8	552.6	372.1	499.9	.2349	.7067	.9416
142	390.9	.754	1.326	129.0	423.4	552.4	370.8	499.8	.2370	.7032	.9402
143	396.2	.743	1.346	130.2	422.0	552.2	369.5	499.7	.2390	.6997	.9387
144	401.5	.732	1.366	131.5	420.5	552.0	368.1	499.6	.2410	.6962	.9372
145	406.9	0.722	1.386	132.8	419.0	551.8	366.7	499.5	0.2430	0.6927	0.9357
146	412.3	.712	1.406	134.0	417.6	551.6	365.4	499.4	.2450	.6892	.9342
147	417.8	.702	1.426	135.2	416.2	551.4	364.0	499.3	.2470	.6857	.9327
148	423.3	.692	1.446	136.4	414.8	551.2	362.7	499.2	.2490	.6822	.9312
149	428.9	.682	1.467	137.7	413.3	551.0	361.3	499.1	.2510	.6787	.9297
150	434.5	0.672	1.488	139.0	411.8	550.8	360.0	499.0	0.2530	0.6752	0.9282
155	463.6	.626	1.597	145.0	404.5	549.5	353.1	498.1	.2635	.6577	.9212
160	494.0	.584	1.712	151.3	396.9	548.2	346.0	497.3	.2739	.6401	.9140
165	526.0	.544	1.838	157.7	389.1	546.8	338.8	496.5	.2843	.6225	.9068
170	559.4	.506	1.976	164.2	381.1	545.3	331.4	495.7	.2947	.6049	.8996
175	594.4	0.472	2.119	170.9	372.8	543.7	323.9	494.9	0.3052	0.5872	0.8924
180	631.2	.441	2.268	177.7	364.3	542.0	316.3	494.1	.3157	.5695	.8852
185	669.5	.412	2.427	184.8	355.6	540.4	308.4	493.3	.3265	.5516	.8781
190	709.5	.385	2.597	192.2	346.5	538.7	300.3	492.5	.3376	.5335	.8711
195	751.4	.358	2.793	199.9	337.2	537.1	291.9	491.8	.3489	.5152	.8641
200	795.1	.334	2.994	207.9	327.5	535.4	283.2	491.1	.3605	.4966	.8571

PRESSURE TABLE

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{T}{L}$	ϕ_1
1	−102.65	219	....	....	....	....	....	....	....	....	....
2	− 86.53	115	....	....	....	....	....	....	....	....	....
3	− 76.28	80	....	....	....	....	....	....	....	....	....
4	− 68.55	61.2	....	....	....	....	....	....	....	....	....
5	− 62.13	49.72	0.02013	−106.2	633.5	527.5	588.5	482.3	−0.2407	1.5940	1.3533
6	− 56.84	41.79	0.02393	−100.4	629.8	529.0	583.9	483.5	−0.2261	1.5661	1.3400
7	− 52.23	36.23	.02760	− 95.3	626.4	530.3	579.8	484.5	− .2135	1.5405	1.3270
8	− 48.13	31.05	.03120	− 90.8	623.2	531.4	576.2	485.4	− .2022	1.5165	1.3143
9	− 44.40	28.75	.03478	− 86.5	620.1	532.6	572.7	486.2	− .1919	1.4945	1.3026
10	− 40.91	26.05	.03839	− 82.9	617.3	533.8	569.8	486.9	− .1826	1.4745	1.2919
11	− 37.76	23.84	0.04195	− 79.3	614.6	534.8	566.8	487.5	−0.1743	1.4570	1.2827
12	− 34.83	21.99	.04548	− 76.0	611.0	535.8	563.8	487.8	− .1665	1.4407	1.2742
13	− 32.10	20.40	.04902	− 73.1	609.6	536.6	561.3	488.2	− .1592	1.4259	1.2667
14	− 29.55	19.02	.05258	− 70.2	607.3	537.5	558.8	488.6	− .1523	1.4122	1.2599
15	− 27.16	17.81	.05615	− 67.5	605.1	538.3	556.7	489.2	− .1458	1.3995	1.2537
16	− 24.87	16.78	0.05959	− 65.0	603.1	538.7	554.5	489.5	−0.1399	1.3872	1.2473
17	− 22.69	15.85	.06309	− 62.4	601.1	539.5	552.2	489.8	− .1343	1.3759	1.2416
18	− 20.61	15.02	.06658	− 60.1	599.2	540.0	550.2	490.1	− .1289	1.3650	1.2361
19	− 18.63	14.30	.06993	− 57.9	597.4	540.5	548.3	490.4	− .1238	1.3549	1.2311
20	− 16.70	13.66	.07321	− 55.7	595.6	541.0	546.4	490.7	− .1188	1.3450	1.2262
21	− 14.84	13.025	0.07680	− 53.6	594.0	541.4	544.5	491.0	−0.1141	1.3358	1.2217
22	− 13.07	12.470	.08019	− 51.6	592.4	541.7	542.8	491.3	− .1096	1.3269	1.2173
23	− 11.36	11.965	.08354	− 49.6	590.8	542.2	541.1	491.5	− .1053	1.3182	1.2139
24	− 9.69	11.490	.08703	− 47.7	589.4	542.6	539.4	491.7	− .1011	1.3102	1.2091
25	− 8.08	11.065	.09033	− 45.9	588.0	543.0	537.8	491.9	− .0970	1.3023	1.2053
26	− 6.54	10.682	0.09363	− 44.2	586.6	543.3	536.3	492.1	−0.0932	1.2950	1.2018
27	− 5.06	10.308	.09699	− 42.5	585.2	543.6	534.8	492.3	− .0895	1.2877	1.1982
28	− 3.59	9.969	.1003	− 40.8	584.0	543.9	533.4	492.5	− .0859	1.2805	1.1946
29	− 2.17	9.649	.1036	− 39.2	582.7	544.2	532.0	492.7	− .0823	1.2740	1.1917
30	− 0.78	9.344	.1070	− 37.6	581.4	544.5	530.6	492.9	− .0789	1.2673	1.1884

PRESSURE TABLE. — *Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
31	+0.57	9.061	0.1104	−36.1	580.2	544.8	529.2	493.1	−0.0755	1.2610	1.1855
32	1.88	8.798	.1137	−34.6	579.1	545.1	527.9	493.3	− .0722	1.2549	1.1827
33	3.17	8.541	.1170	−33.1	577.9	545.4	526.6	493.5	− .0690	1.2490	1.1800
34	4.43	8.302	.1205	−31.7	576.8	545.6	525.3	493.7	− .0659	1.2431	1.1772
35	5.65	8.084	.1238	−30.3	575.7	545.9	524.0	493.9	− .0628	1.2374	1.1746
36	6.83	7.870	0.1271	−28.9	574.7	546.2	522.8	494.1	−0.0599	1.2321	1.1722
37	8.00	7.667	.1305	−27.6	573.6	546.4	521.6	494.3	− .0571	1.2269	1.1688
38	9.14	7.478	.1337	−26.3	572.6	546.6	520.5	494.4	− .0543	1.2218	1.1675
39	10.25	7.292	.1368	−25.0	571.6	546.8	519.4	494.5	− .0516	1.2168	1.1652
40	11.34	7.117	.1403	−23.7	570.6	547.0	518.3	494.6	− .0490	1.2119	1.1629
41	12.42	6.951	0.1438	−22.4	569.6	547.3	517.2	494.7	−0.0464	1.2067	1.1603
42	13.48	6.797	.1471	−21.2	568.6	547.5	516.1	494.8	− .0438	1.2018	1.1580
43	14.53	6.646	.1505	−20.0	567.7	547.7	515.0	494.9	− .0413	1.1969	1.1556
44	15.56	6.504	.1538	−18.8	566.7	547.9	513.9	495.0	− .0388	1.1924	1.1535
45	16.58	6.366	.1570	−17.7	565.8	548.0	512.9	495.1	− .0364	1.1879	1.1514
46	17.59	6.239	0.1603	−16.6	564.8	548.2	511.9	495.2	−0.0341	1.1835	1.1494
47	18.56	6.116	.1635	−15.5	563.9	548.4	510.9	495.3	− .0318	1.1792	1.1474
48	19.48	5.998	.1667	−14.4	563.0	548.6	509.9	495.4	− .0295	1.1749	1.1454
49	20.37	5.885	.1699	−13.3	562.1	548.8	509.0	495.5	− .0273	1.1708	1.1435
50	21.29	5.776	.1731	−12.2	561.2	549.0	508.1	495.6	− .0252	1.1671	1.1416
51	22.20	5.671	0.1763	−11.3	560.3	549.1	507.1	495.7	−0.0231	1.1628	1.1397
52	23.10	5.569	.1796	−10.2	559.4	549.2	506.3	495.8	− .0210	1.1590	1.1379
53	23.97	5.471	.1828	− 9.2	558.5	549.3	505.4	496.1	− .0189	1.1552	1.1361
54	24.84	5.376	.1860	− 8.2	557.7	549.5	504.5	496.0	− .0169	1.1514	1.1343
55	25.70	5.284	.1893	− 7.2	556.9	549.7	503.6	496.1	− .0149	1.1476	1.1326
56	26.53	5.195	0.1925	− 6.2	556.1	549.9	502.7	496.4	−0.0129	1.1439	1.1309
57	27.34	5.109	.1957	− 5.3	555.3	550.0	501.8	496.3	− .0110	1.1403	1.1292
58	28.14	5.024	.1990	− 4.4	554.5	550.1	501.0	496.4	− .0091	1.1367	1.1275
59	28.95	4.941	.2024	− 3.5	553.7	550.2	500.2	496.5	− .0072	1.1331	1.1259
60	29.76	4.861	.2057	− 2.6	552.9	550.3	499.4	496.6	− .0053	1.1299	1.1243

PRESSURE TABLE. — *Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
61	30.56	4.784	0.2090	− 1.7	552.1	550.4	498.6	496.7	−0.0035	1.1261	1.1227
62	31.34	4.711	.2123	− 0.8	551.3	550.5	497.8	496.8	− .0017	1.1227	1.1211
63	32.11	4.640	.2155	+ 0.1	550.6	550.7	497.0	496.9	+ .0002	1.1194	1.1196
64	32.87	4.571	.2188	1.0	549.9	550.9	496.2	497.0	.0020	1.1162	1.1181
65	33.62	4.505	.2220	1.9	549.2	551.1	495.4	497.1	.0038	1.1130	1.1166
66	34.36	4.440	0.2252	2.7	548.5	551.2	494.6	497.2	0.0055	1.1098	1.1151
67	35.10	4.378	.2284	3.5	547.8	551.3	493.9	497.3	.0072	1.1066	1.1137
68	35.81	4.317	.2316	4.3	547.1	551.4	493.2	497.4	.0089	1.1036	1.1123
69	36.51	4.256	.2350	5.1	546.4	551.5	492.5	497.5	.0105	1.1005	1.1109
70	37.22	4.197	.2383	5.9	545.7	551.6	491.8	497.6	.0121	1.0984	1.1096
71	37.93	4.139	0.2416	6.7	545.0	551.7	491.1	497.7	0.0137	1.0947	1.1083
72	38.64	4.084	.2449	7.5	544.3	551.8	490.4	497.8	.0153	1.0918	1.1070
73	39.34	4.030	.2481	8.3	543.6	551.9	489.7	497.9	.0169	1.0889	1.1057
74	40.00	3.977	.2514	9.1	542.9	552.0	489.0	498.0	.0185	1.0860	1.1044
75	40.66	3.927	.2546	9.9	542.2	552.1	488.3	498.1	.0200	1.0832	1.1032
76	41.32	3.879	0.2578	10.7	541.5	552.2	487.6	498.2	0.0215	1.0804	1.1020
77	41.97	3.832	.2610	11.5	540.9	552.4	486.9	498.3	.0230	1.0777	1.1008
78	42.67	3.785	.2642	12.2	540.3	552.5	486.2	498.3	.0245	1.0750	1.0996
79	43.28	3.740	.2674	12.9	539.7	552.6	485.5	498.4	.0260	1.0723	1.0984
80	43.88	3.696	.2706	13.6	539.1	552.7	484.8	498.4	.0275	1.0706	1.0972
81	44.54	3.653	0.2737	14.3	538.5	552.8	484.2	498.5	0.0289	1.0671	1.0961
82	45.17	3.610	.2770	15.0	537.9	552.9	483.5	498.5	.0303	1.0646	1.0950
83	45.80	3.568	.2803	15.7	537.3	553.0	482.9	498.6	.0317	1.0621	1.0949
84	46.41	3.527	.2835	16.4	536.6	553.0	482.2	498.6	.0331	1.0596	1.0928
85	47.02	3.485	.2868	17.2	535.9	553.1	481.5	498.7	.0345	1.0572	1.0917
86	47.63	3.446	0.2902	17.9	535.3	553.2	480.9	498.8	0.0359	1.0547	1.0906
87	48.23	3.407	.2935	18.5	534.8	553.3	480.3	498.8	.0372	1.0523	1.0895
88	48.82	3.370	.2967	19.2	534.2	553.4	479.8	499.0	.0385	1.0499	1.0884
89	49.39	3.335	.2999	20.0	533.5	553.5	479.0	499.0	.0398	1.0475	1.0873
90	49.97	3.300	.3030	20.7	532.8	553.5	478.4	499.1	.0411	1.0462	1.0863

PRESSURE TABLE.—*Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
91	50.55	3.265	0.3063	21.4	532.2	553.6	477.7	499.1	0.0424	1.0429	1.0853
92	51.13	3.231	.3095	21.9	531.8	553.7	477.3	499.2	.0437	1.0406	1.0843
93	51.70	3.199	.3126	22.6	531.2	553.8	476.6	499.2	.0450	1.0383	1.0833
94	52.27	3.166	.3159	23.3	530.5	553.8	476.0	499.3	.0463	1.0361	1.0823
95	52.83	3.134	.3191	23.9	530.0	553.9	475.5	499.4	.0476	1.0339	1.0813
96	53.39	3.102	0.3223	24.5	529.4	553.9	474.9	499.4	0.0489	1.0317	1.0803
97	53.95	3.070	.3257	25.3	528.7	554.0	474.2	499.5	.0501	1.0295	1.0794
98	54.50	3.039	.3291	25.9	528.1	554.0	473.6	499.5	.0513	1.0273	1.0785
99	55.04	3.009	.3323	26.4	527.7	554.1	473.1	499.5	.0525	1.0252	1.0776
100	55.58	2.980	.3356	27.1	527.0	554.1	472.4	499.5	.0537	1.0232	1.0767
101	56.10	2.952	0.3388	27.6	526.6	554.2	471.9	499.5	0.0549	1.0210	1.0758
102	56.62	2.924	.3420	28.2	526.0	554.2	471.4	499.6	.0561	1.0189	1.0749
103	57.13	2.897	.3452	28.8	525.5	554.3	470.8	499.6	.0573	1.0168	1.0740
104	57.63	2.870	.3484	29.4	525.0	554.4	470.1	499.7	.0584	1.0147	1.0731
105	58.14	2.844	.3516	30.0	524.4	554.4	469.7	499.7	.0596	1.0126	1.0722
106	58.65	2.817	0.3550	30.6	523.9	554.5	469.2	499.8	0.0607	1.0105	1.0713
107	59.15	2.791	.3583	31.1	523.4	554.5	468.7	499.8	.0618	1.0085	1.0704
108	59.66	2.765	.3617	31.8	522.8	554.6	468.1	499.9	.0629	1.0065	1.0695
109	60.16	2.740	.3650	32.4	522.2	554.6	467.5	499.9	.0640	1.0045	1.0686
110	60.67	2.716	.3682	33.0	521.7	554.7	466.9	499.9	.0651	1.0028	1.0677
111	61.18	2.692	0.3715	33.5	521.2	554.7	466.4	499.9	0.0662	1.0006	1.0669
112	61.68	2.669	.3747	34.1	520.7	554.8	465.8	499.9	.0673	.9985	1.0660
113	62.19	2.646	.3779	34.7	520.1	554.8	465.3	500.0	.0684	.9965	1.0649
114	62.69	2.624	.3811	35.3	519.5	554.8	464.7	500.0	.0695	.9945	1.0640
115	63.19	2.602	.3843	35.8	519.1	554.9	464.2	500.0	.0706	.9926	1.0632
116	63.61	2.580	0.3876	36.3	518.6	554.9	463.7	500.0	0.0717	0.9908	1.0624
117	64.14	2.559	.3908	36.8	518.1	554.9	463.3	500.1	.0728	.9890	1.0616
118	64.59	2.538	.3940	37.4	517.6	555.0	462.7	500.1	.0738	.9872	1.0608
119	65.02	2.517	.3973	37.9	517.1	555.0	462.3	500.2	.0748	.9854	1.0600
120	65.49	2.497	.4005	38.5	516.6	555.1	461.7	500.2	.0758	.9841	1.0592

PRESSURE TABLE.—*Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_3	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
121	65.94	2.477	0.4037	39.0	516.1	555.1	461.3	500.3	.0768	0.9818	1.0585
122	66.41	2.457	.4070	39.5	515.6	555.1	460.8	500.3	.0778	.9800	1.0577
123	66.85	2.437	.4103	40.0	515.1	555.1	460.4	500.4	.0788	.9782	1.0570
124	67.33	2.418	.4136	40.5	514.6	555.1	459.9	500.4	.0798	.9765	1.0563
125	67.81	2.400	.4167	41.1	514.1	555.2	459.4	500.5	.0808	.9747	1.0555
126	68.27	2.382	0.4198	41.7	513.5	555.2	458.8	500.5	0.0818	0.9729	1.0547
127	68.7	2.363	.4232	42.2	513.1	555.3	458.4	500.6	.0828	.9711	1.0539
128	69.2	2.345	.4266	42.8	512.5	555.3	457.8	500.6	.0838	.9693	1.0531
129	69.6	2.327	.4297	43.3	512.0	555.3	457.3	500.6	.0848	.9676	1.0524
130	70.1	2.309	.4330	43.9	511.4	555.3	456.8	500.7	.0858	.9659	1.0517
131	70.5	2.292	0.4363	44.3	511.1	555.4	456.4	500.7	0.0868	0.9642	1.0510
132	70.9	2.275	.4396	44.8	510.6	555.4	455.9	500.7	.0878	.9625	1.0503
133	71.3	2.259	.4427	45.2	510.2	555.4	455.5	500.7	.0887	.9608	1.0495
134	71.7	2.243	.4458	45.7	509.7	555.4	455.1	500.8	.0896	.9591	1.0487
135	72.2	2.227	.4490	46.3	509.2	555.5	454.5	500.8	.0905	.9575	1.0480
136	72.6	2.201	0.4543	46.8	508.7	555.5	454.0	500.8	0.0914	0.9559	1.0473
137	73.0	2.196	.4554	47.2	508.3	555.5	453.6	500.8	.0923	.9543	1.0466
138	73.4	2.180	.4587	47.7	507.8	555.5	453.1	500.8	.0932	.9527	1.0459
139	73.8	2.164	.4621	48.2	507.4	555.6	452.7	500.9	.0941	.9510	1.0451
140	74.2	2.149	.4653	48.7	506.9	555.6	452.2	500.9	.0950	.9497	1.0444
141	74.7	2.134	0.4686	49.2	506.4	555.6	451.7	500.9	0.0959	0.9478	1.0437
142	75.1	2.119	.4719	49.6	506.0	555.6	451.2	500.9	.0968	.9462	1.0430
143	75.5	2.105	.4751	50.1	505.5	555.7	450.8	501.0	.0977	.9447	1.0424
144	75.9	2.090	.4785	50.6	505.1	555.7	450.4	501.0	.0986	.9432	1.0418
145	76.3	2.076	.4817	51.1	504.7	555.7	449.9	501.0	.0995	.9417	1.0412
146	76.7	2.063	0.4847	51.6	504.2	555.8	449.4	501.0	0.1004	0.9402	1.0406
147	77.1	2.049	.4880	52.0	503.8	555.8	449.0	501.0	.1013	.9387	1.0400
148	77.5	2.035	.4914	52.5	503.3	555.8	448.6	501.1	.1022	.9372	1.0394
149	77.9	2.021	.4948	53.0	502.9	555.9	448.1	501.1	.1030	.9357	1.0387
150	78.3	2.008	.4980	53.4	502.5	555.9	447.7	501.1	.1039	.9342	1.0381

PRESSURE TABLE. — *Continued*

Pressure, lb. p	Temp., °F. t	Sp. vol., cu. ft. per lb. v_1	Density, lb. per cu. ft. $\frac{1}{v_1}$	Heat content of liquid Q_2	Latent heat of liquid L	Heat content of vapor Q_1	Internal energy, B.t.u. Evap. U_2	Internal energy, B.t.u. Vapor U_1	Entropy Liquid ϕ_2	Entropy Evap. $\frac{L}{T}$	Entropy Vapor ϕ_1
151	78.7	1.995	0.5013	53.8	502.1	555.9	447.3	501.1	0.1048	0.9326	1.0374
152	79.1	1.982	.5045	54.3	501.6	555.9	446.8	501.1	.1056	.9311	1.0367
153	79.4	1.969	.5079	54.8	501.2	556.0	446.4	501.2	.1065	.9296	1.0361
154	79.8	1.957	.5110	55.2	500.8	556.0	446.0	501.2	.1074	.9281	1.0355
155	80.2	1.944	.5144	55.7	500.3	556.0	445.5	501.2	.1082	.9266	1.0348
156	80.6	1.931	0.5179	56.1	499.9	556.0	445.1	501.2	0.1090	0.9252	1.0342
157	81.0	1.919	.5211	56.6	499.5	556.1	444.7	501.3	.1098	.9238	1.0336
158	81.3	1.907	.5244	57.0	499.1	556.1	444.3	501.3	.1106	.9224	1.0330
159	81.7	1.895	.5277	57.4	498.7	556.1	443.9	501.3	.1114	.9210	1.0324
160	82.1	1.885	.5305	57.8	498.3	556.1	443.5	501.3	.1122	.9199	1.0318
161	82.5	1.873	0.5339	58.3	497.9	556.2	443.0	501.3	0.1130	0.9182	1.0312
162	82.9	1.861	.5373	58.8	497.4	556.2	442.6	501.4	.1138	.9168	1.0306
163	83.3	1.849	.5408	59.2	497.0	556.2	442.2	501.4	.1146	.9154	1.0300
164	83.7	1.838	.5441	59.6	496.6	556.2	441.8	501.4	.1154	.9140	1.0294
165	84.0	1.828	.5470	60.1	496.2	556.3	441.3	501.4	.1162	.9126	1.0288
166	84.4	1.817	0.5504	60.5	495.8	556.3	440.9	501.4	0.1170	0.9113	1.0283
167	84.8	1.806	.5537	60.9	495.4	556.3	440.5	501.4	.1178	.9099	1.0277
168	85.1	1.796	.5568	61.3	495.0	556.3	440.1	501.4	.1186	.9085	1.0271
169	85.4	1.786	.5599	61.7	494.6	556.4	439.7	501.4	.1194	.9071	1.0265
170	85.8	1.776	.5631	62.2	494.2	556.4	439.3	501.5	.1201	.9062	1.0259
171	86.2	1.766	0.5663	62.7	493.7	556.4	438.8	501.5	0.1208	0.9045	1.0253
172	86.5	1.756	.5695	63.1	493.3	556.4	438.4	501.5	.1216	.9032	1.0248
173	86.9	1.746	.5727	63.5	492.9	556.4	438.0	501.5	.1224	.9019	1.0243
174	87.2	1.736	.5760	63.9	492.5	556.4	437.6	501.5	.1231	.9006	1.0237
175	87.6	1.726	.5794	64.3	492.1	556.4	437.2	501.5	.1239	.8992	1.0231
176	87.9	1.716	0.5828	64.7	491.8	556.5	436.8	501.5	0.1247	0.8979	1.0226
177	88.3	1.706	.5862	65.1	491.4	556.5	436.4	501.5	.1255	.8965	1.0220
178	88.6	1.696	.5896	65.5	491.0	556.5	436.0	501.5	.1263	.8952	1.0215
179	89.0	1.687	.5928	65.9	490.6	556.5	435.6	501.6	.1270	.8939	1.0209
180	89.3	1.677	.5963	66.3	490.2	556.5	435.3	501.6	.1277	.8920	1.0204

PRESSURE TABLE. — *Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
181	89.7	1.668	0.5995	66.7	489.8	556.5	435.9	501.6	0.1284	0.8914	1.0198
182	90.0	1.659	.6028	67.1	489.4	556.5	434.5	501.6	.1291	.8902	1.0193
183	90.4	1.650	.6061	67.5	489.0	556.5	434.1	501.6	.1298	.8889	1.0187
184	90.7	1.641	.6094	67.9	488.6	556.5	433.7	501.6	.1205	.8877	1.0182
185	91.0	1.633	.6124	68.3	488.2	556.5	433.3	501.6	.1312	.8865	1.0177
186	91.4	1.624	0.6158	68.7	487.8	556.5	433.0	501.7	0.1319	0.8852	1.0171
187	91.7	1.615	.6192	69.1	487.4	556.5	432.6	501.7	.1327	.8839	1.0166
188	92.0	1.606	.6227	69.5	487.0	556.5	432.2	501.7	.1334	.8827	1.0161
189	92.4	1.597	.6262	69.9	486.6	556.5	431.8	501.7	.1341	.8814	1.0155
190	92.7	1.589	.6293	70.3	486.2	556.5	431.4	501.7	.1348	.8804	1.0149
191	93.0	1.581	0.6325	70.7	485.9	556.6	431.0	501.7	0.1354	0.8789	1.0143
192	93.4	1.573	.6357	71.1	485.5	556.6	430.6	501.7	.1361	.8777	1.0138
193	93.7	1.565	.6390	71.5	485.1	556.6	430.2	501.7	.1368	.8765	1.0133
194	94.0	1.557	.6423	71.9	484.7	556.6	429.8	501.7	.1374	.8753	1.0127
195	94.3	1.549	.6456	72.3	484.3	556.6	429.4	501.7	.1381	.8741	1.0122
196	94.6	1.541	0.6489	72.7	483.9	556.6	429.0	501.7	0.1388	0.8729	1.0117
197	94.9	1.533	.6523	73.1	483.5	556.6	428.6	501.7	.1394	.8718	1.0112
198	95.2	1.525	.6557	73.5	483.1	556.6	428.3	501.8	.1401	.8706	1.0107
199	95.5	1.517	.6592	73.8	482.8	556.6	428.0	501.8	.1408	.8694	1.0102
200	95.9	1.510	.6623	74.1	482.5	556.6	427.7	501.8	.1414	.8685	1.0097
202	96.5	1.495	0.6689	74.9	481.7	556.6	426.9	501.8	.1428	0.8659	1.0087
204	97.1	1.480	.6757	75.6	481.0	556.6	426.2	501.8	.1441	.8636	1.0077
206	97.8	1.466	.6821	76.3	480.3	556.6	425.5	501.8	.1454	.8613	1.0067
208	98.4	1.452	.6887	77.0	479.6	556.6	424.8	501.8	.1467	.8591	1.0058
210	99.0	1.438	.6954	77.7	478.8	556.5	424.1	501.8	.1479	.8569	1.0048

PRESSURE TABLE.—*Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
212	99.6	1.424	0.7022	78.4	478.1	556.5	423.4	501.8	0.1492	0.8547	1.0039
214	100.2	1.410	.7092	79.1	477.4	556.5	422.7	501.8	.1505	.8525	1.0030
216	100.8	1.397	.7158	79.8	476.7	556.5	422.0	501.8	.1517	.8504	1.0021
218	101.4	1.384	.7225	80.5	476.0	556.5	421.3	501.8	.1529	.8483	1.0012
220	102.0	1.371	.7294	81.2	475.3	556.5	420.6	501.8	.1541	.8462	1.0003
222	102.6	1.358	0.7364	81.9	474.6	556.5	419.9	501.8	0.1554	0.8440	0.9994
224	103.2	1.346	.7429	82.6	473.9	556.5	419.2	501.8	.1566	.8419	.9985
226	103.7	1.334	.7496	83.3	473.2	556.5	418.5	501.8	.1578	.8398	.9976
228	104.3	1.323	.7559	84.0	472.5	556.5	417.8	501.8	.1590	.8377	.9967
230	104.9	1.312	.7622	84.6	471.8	556.4	417.2	501.8	.1602	.8357	.9959
232	105.5	1.300	0.7692	85.3	471.1	556.4	416.5	501.8	0.1614	0.8336	0.9950
234	106.0	1.289	.7758	85.9	470.5	556.4	415.9	501.8	.1626	.8316	.9942
236	106.6	1.278	.7825	86.6	469.8	556.4	415.2	501.8	.1637	.8296	.9933
238	107.2	1.267	.7893	87.2	469.1	556.3	414.6	501.8	.1649	.8276	.9925
240	107.7	1.256	.7962	87.9	468.4	556.3	413.9	501.8	.1660	.8256	.9916
242	108.2	1.245	0.8032	88.5	467.7	556.2	413.2	501.7	0.1672	0.8236	0.9908
244	108.8	1.234	.8104	89.2	467.0	556.2	412.5	501.7	.1683	.8216	.9899
246	109.3	1.224	.8170	89.8	466.3	556.1	411.9	501.7	.1695	.8196	.9891
248	109.9	1.214	.8237	90.5	465.6	556.1	411.2	501.7	.1706	.8176	.9882
250	110.4	1.204	.8306	91.1	464.9	556.0	410.6	501.7	.1717	.8157	.9874
252	111.0	1.195	0.8368	91.7	464.3	556.0	410.0	501.7	0.1728	0.8138	0.9866
254	111.5	1.185	.8439	92.3	463.7	555.0	409.4	501.7	.1739	.8119	.9858
256	112.0	1.176	.8503	92.9	463.0	555.9	408.8	501.7	.1750	.8100	.9850
258	112.5	1.167	.8569	93.6	462.3	555.9	408.1	501.7	.1761	.8081	.9842
260	113.1	1.158	.8636	94.2	461.7	555.9	407.5	501.7	.1771	.8063	.9834

PRESSURE TABLE.—*Continued*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_2	$\frac{L}{T}$	ϕ_1
262	113.6	1.149	0.8703	94.8	461.0	555.8	406.9	501.7	0.1782	0.8044	0.9826
264	114.1	1.140	.8772	95.4	460.4	555.8	406.2	501.6	.1792	.8026	.9818
266	114.6	1.131	.8842	96.0	459.7	555.7	405.6	501.6	.1803	.8007	.9810
268	115.1	1.122	.8913	96.6	459.1	555.7	405.0	501.6	.1813	.7989	.9802
270	115.6	1.113	.8985	97.2	458.5	555.7	404.4	501.6	.1824	.7971	.9795
272	116.1	1.104	0.9058	97.8	457.8	555.6	403.8	501.6	0.1834	0.7953	0.9787
274	116.6	1.096	.9124	98.4	457.2	555.6	403.1	501.5	.1845	.7935	.9780
276	117.1	1.088	.9191	99.0	456.5	555.5	402.5	501.5	.1855	.7917	.9772
278	117.6	1.080	.9259	99.6	455.9	555.5	401.9	501.5	.1866	.7899	.9765
280	118.1	1.072	.9328	100.2	455.3	555.5	401.2	501.4	.1876	.7881	.9757
282	118.6	1.064	0.9398	100.8	454.6	555.4	400.6	501.4	0.1887	0.7863	0.9750
284	119.1	1.056	.9470	101.3	454.0	555.3	400.0	501.3	.1897	.7846	.9743
286	119.5	1.049	.9533	101.9	453.4	555.3	399.4	501.3	.1906	.7829	.9735
288	120.0	1.043	.9606	102.4	452.9	555.3	398.8	501.2	.1916	.7812	.9728
290	120.5	1.034	.9671	103.0	452.2	555.2	398.2	501.2	.1926	.7795	.9721
292	121.0	1.026	0.9747	103.6	451.6	555.2	397.6	501.2	0.1936	0.7778	0.9714
294	121.4	1.019	.9814	104.1	451.0	555.1	397.1	501.2	.1946	.7761	.9707
296	121.9	1.012	.9881	104.7	450.4	555.1	396.5	501.2	.1956	.7744	.9700
298	122.4	1.005	.9950	105.3	449.8	555.1	395.9	501.2	.1966	.7727	.9693
300	122.9	0.998	1.002	105.9	449.2	555.0	395.3	501.2	.1976	.7710	.9686
310	125.2	0.965	1.036	108.6	446.2	554.8	392.5	501.1	0.2023	0.7626	0.9649
320	127.4	.932	1.073	111.3	443.2	554.5	389.6	500.9	.2069	.7545	.9614
330	129.6	.904	1.106	114.1	440.3	554.4	386.8	500.9	.2115	.7468	.9583
340	131.8	.876	1.142	116.7	437.4	554.1	384.1	500.8	.2160	.7390	.9550
350	133.9	.849	1.178	119.2	434.6	553.8	381.4	500.6	.2203	.7316	.9519

PRESSURE TABLE.—*Concluded*

Pressure, lb.	Temp., °F.	Sp. vol., cu. ft. per lb.	Density, lb. per cu. ft.	Heat content of liquid	Latent heat of liquid	Heat content of vapor	Internal energy, B.t.u.		Entropy		
							Evap.	Vapor	Liquid	Evap.	Vapor
p	t	v_1	$\frac{1}{v_1}$	Q_2	L	Q_1	U_2	U_1	ϕ_1	$\frac{L}{T}$	ϕ_1
360	135.9	0.824	1.214	121.6	431.8	553.4	378.8	500.4	0.2245	0.7244	0.9489
370	137.9	.800	1.250	124.1	429.0	553.1	376.1	500.2	.2285	.7175	.9460
380	139.9	.777	1.287	126.5	426.3	552.8	373.5	500.0	.2326	.7106	.9432
390	141.8	.756	1.323	128.8	423.6	552.4	371.0	499.8	.2366	.7038	.9404
400	143.7	.736	1.359	131.1	420.9	552.0	368.5	499.6	.2404	.6972	.9376
410	145.6	0.717	1.395	133.5	418.2	551.7	365.9	499.4	0.2441	0.6908	0.9349
420	147.4	.698	1.433	135.7	415.6	551.3	363.4	499.1	.2478	.6844	.9322
430	149.2	.680	1.471	137.9	413.0	550.9	361.0	498.9	.2515	.6780	.9295
440	151.0	.662	1.511	140.1	410.4	550.5	358.6	498.7	.2551	.6718	.9269
450	152.7	.646	1.548	142.2	407.9	550.1	356.3	498.5	.2587	.6657	.9244
460	154.4	0.631	1.585	144.2	405.4	549.6	354.0	498.2	0.2622	0.6598	0.9220
470	156.1	.617	1.621	146.3	402.9	549.2	351.7	498.0	.2657	.6540	.9197
480	157.8	.603	1.658	148.4	400.4	548.8	349.3	497.7	.2691	.6482	.9173
490	159.4	.589	1.698	150.4	397.9	548.3	347.0	497.4	.2726	.6424	.9150
500	160.9	.576	1.736	152.5	395.4	547.9	344.6	497.1	.2759	.6368	.9127
525	164.8	0.545	1.835	157.5	389.2	546.7	339.0	496.5	0.2838	0.6232	0.9070
550	168.6	.517	1.934	162.4	383.2	545.6	333.5	495.9	.2916	.6099	.9015
575	172.3	.492	2.033	167.2	377.3	544.5	328.1	495.3	.2993	.5970	.8963
600	175.8	.467	2.141	171.9	371.5	543.4	322.8	494.7	.3068	.5845	.8913
625	179.2	0.447	2.237	176.6	365.7	542.3	317.6	494.2	0.3141	0.5724	0.8865
650	182.5	.427	2.342	181.3	359.9	541.2	312.4	493.7	.3213	.5605	.8818
675	185.7	.408	2.451	185.9	354.2	540.1	307.3	493.2	.3283	.5489	.8772
700	188.8	.391	2.558	190.5	348.6	539.1	302.2	492.7	.3350	.5378	.8728

SUPERHEATED AMMONIA (Nos. 5 to 12)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
5	Temp.	−62.13		−52.13	−42.13	−32.13	−22.13	−12.13	− 2.13	+ 7.87	+17.87	+27.87	+37.87
	Q	−106.2	527.5	532.5	537.4	542.4	547.3	552.3	557.3	562.4	567.4	572.5	577.5
	Vol.	0.02260	49.72	50.996	52.271	53.545	54.818	56.090	57.361	58.627	59.729	61.169	62.436
	φ	− .2407	1.3533	1.3658	1.3775	1.3893	1.4008	1.4121	1.4232	1.4339	1.4443	1.4551	1.4653
6	Temp.	−56.84		−46.84	−36.84	−26.84	−16.84	− 6.84	+ 3.16	+13.16	+26.16	+36.16	+46.16
	Q	−100.4	529.0	534.0	539.0	543.9	548.9	553.9	558.9	563.9	569.0	574.0	579.0
	Vol.	0.02273	41.79	42.783	43.772	44.758	45.740	46.859	47.696	48.670	49.642	50.522	51.580
	φ	− .2261	1.3400	1.3525	1.3643	1.3760	1.3874	1.3985	1.4096	1.4204	1.4309	1.4415	1.4518
7	Temp.	−52.23		−42.23	−32.23	−22.23	−12.23	− 2.23	+ 7.77	+17.77	+27.77	+37.77	+47.77
	Q	− 95.3	530.3	535.3	540.3	545.3	550.3	555.3	560.3	565.3	570.4	575.4	580.4
	Vol.	0.02286	36.23	37.148	38.002	38.931	39.847	40.780	41.700	42.618	43.533	44.447	45.359
	φ	− .2135	1.3270	1.3395	1.3512	1.3629	1.3742	1.3854	1.3965	1.4072	1.4178	1.4283	1.4387
8	Temp.	−48.13		−38.13	−28.13	−18.13	− 8.13	+ 1.87	+11.87	+21.87	+31.87	+41.87	+51.87
	Q	− 90.8	531.4	536.4	541.4	546.4	551.4	556.4	561.4	566.4	571.5	576.5	581.5
	Vol.	0.02298	32.05	32.590	33.432	34.273	35.112	35.950	36.787	37.623	38.455	39.251	40.046
	φ	− .2022	1.3143	1.3267	1.3384	1.3502	1.3614	1.3726	1.3837	1.3943	1.4050	1.4155	1.4258
9	Temp.	−44.40		−34.40	−24.40	−14.40	− 4.40	+ 5.60	+15.60	+25.60	+35.60	+45.60	+55.60
	Q	− 86.5	532.6	537.6	542.6	547.7	552.7	557.7	562.7	567.7	572.7	577.8	582.8
	Vol.	0.02308	28.75	29.131	29.872	30.610	31.349	32.081	32.814	33.545	34.276	35.005	35.733
	φ	− .1919	1.3026	1.3150	1.3266	1.3385	1.3497	1.3608	1.3718	1.3826	1.3931	1.4036	1.4139
10	Temp.	−40.91		−30.91	−20.91	−10.91	− 0.91	+ 9.19	+19.19	+29.19	+39.19	+49.19	+59.19
	Q	− 82.9	533.8	538.8	543.8	548.9	553.9	558.9	563.9	569.0	574.0	579.1	584.1
	Vol.	0.02318	26.05	26.647	27.293	27.950	28.581	29.210	29.199	30.467	31.094	31.719	32.345
	φ	− .1826	1.2919	1.3042	1.3159	1.3277	1.3389	1.3500	1.3610	1.3719	1.3822	1.3928	1.4030
11	Temp.	−37.76		−27.76	−17.76	− 7.76	+ 2.24	+12.24	+22.24	+32.24	+42.24	+52.24	+62.24
	Q	− 79.3	534.8	539.8	544.8	549.9	554.9	559.9	564.9	570.0	575.0	580.1	585.1
	Vol.	0.02326	23.84	24.416	25.012	25.597	26.181	26.764	27.307	27.927	28.507	29.086	29.664
	φ	− .1743	1.2827	1.2949	1.3067	1.3184	1.3297	1.3407	1.3517	1.3626	1.3729	1.3835	1.3937
12	Temp.	−34.83		−24.83	−14.83	− 4.83	+ 5.17	+15.17	+25.17	+35.17	+45.17	+55.17	+65.17
	Q	− 76.0	535.8	538.8	545.8	550.9	555.9	560.9	566.0	571.0	576.1	581.1	586.2
	Vol.	0.02333	21.99	22.53	23.06	23.60	24.13	24.67	25.30	25.73	26.27	26.80	27.33
	φ	− .1665	1.2742	1.2865	1.2982	1.3097	1.3212	1.3322	1.3431	1.3540	1.3643	1.3747	1.3850

SUPERHEATED AMMONIA (Nos. 5 to 12). — *Continued*

No.		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
5	Temp.	−62.13		+47.87	+57.87	+67.87	+ 77.87	+ 87.87	+ 97.87	+117.87	+137.87	+187.87	+237.87
	Q	−106.2	527.5	582.6	587.6	592.7	597.7	602.8	607.9	618.04	628.2	653.8	679.6
	Vol.	0.02260	49.72	63.703	64.969	66.235	67.499	68.764	69.987	72.526	75.064	81.402	87.730
	φ	− .2407	1.3533	1.4753	1.4863	1.4951	1.5045	1.5138	1.5233	1.5410	1.5585	1.5996	1.6379
6	Temp.	−56.84		+56.16	+66.16	+76.16	+ 86.16	+ 96.16	+106.16	+126.16	+146.16	+196.16	+246.16
	Q	−100.4	529.0	584.1	589.1	594.2	599.2	604.8	609.4	619.6	629.8	655.4	681.2
	Vol.	0.02273	41.79	52.547	53.512	54.476	55.438	56.400	57.549	59.844	62.138	67.866	73.59
	φ	− .2261	1.3400	1.4618	1.4718	1.4815	1.4910	1.5002	1.5098	1.5274	1.5450	1.5860	1.6241
7	Temp.	−52.23		+57.77	+67.77	+77.77	+ 87.77	+ 97.77	+107.77	+127.77	+147.77	+197.77	+247.77
	Q	− 95.3	530.3	585.5	590.5	595.6	600.6	605.7	610.8	621.0	631.2	656.8	682.7
	Vol.	0.02286	36.23	46.270	47.179	48.087	48.994	49.900	50.811	52.642	54.449	58.993	63.53
	φ	− .2135	1.3270	1.4486	1.4585	1.4683	1.4779	1.4870	1.4963	1.5141	1.5318	1.5728	1.6108
8	Temp.	−48.13		+61.87	+71.87	+81.87	+ 91.87	+101.87	+111.87	+131.87	+151.87	+201.87	+251.87
	Q	− 90.8	531.4	586.6	591.7	596.7	601.8	606.9	612.0	622.2	632.4	658.0	683.9
	Vol.	0.02298	32.05	40.839	41.634	42.426	43.218	44.01	44.812	46.413	48.012	51.908	55.90
	φ	− .2022	1.3143	1.4357	1.4456	1.4553	1.4650	1.4741	1.4833	1.5011	1.5187	1.5596	1.5977
9	Temp.	−44.40		+65.60	+75.60	+85.60	+ 95.60	+105.60	+115.60	+135.60	+155.60	+205.60	+255.60
	Q	− 86.5	532.6	587.9	592.9	598.0	603.0	608.1	613.2	623.5	633.7	659.4	685.3
	Vol.	0.02308	28.75	36.460	37.186	37.890	38.585	39.281	40.055	41.449	42.893	46.398	50.0
	φ	− .1919	1.3026	1.4238	1.4337	1.4435	1.4531	1.4622	1.4714	1.4891	1.5066	1.5476	1.5856
10	Temp.	−40.91		+69.19	+79.19	+89.19	+ 99.19	+109.19	+119.19	+139.19	+159.19	+209.19	+259.19
	Q	− 82.9	533.8	589.2	594.2	598.9	603.9	609.4	614.5	624.8	635.0	660.7	686.7
	Vol.	0.02318	26.05	33.069	33.693	34.286	34.938	35.560	36.455	37.693	38.929	42.015	45.231
	φ	− .1826	1.2919	1.4129	1.4229	1.4326	1.4422	1.4513	1.4604	1.4782	1.4958	1.5367	1.5747
11	Temp.	−37.76		+72.24	+82.24	+92.24	+102.24	+112.24	+122.24	+142.24	+162.24	+212.24	+262.24
	Q	− 79.3	534.8	590.2	595.3	600.2	605.4	610.5	615.6	625.9	636.1	661.8	687.8
	Vol.	0.02326	23.84	30.239	30.817	31.390	31.969	32.541	33.233	34.376	35.524	38.388	41.220
	φ	− .1743	1.2827	1.4036	1.4135	1.4232	1.4327	1.4417	1.4509	1.4687	1.4862	1.5271	1.5651
12	Temp.	−34.83		+75.17	+85.17	+95.17	+105.17	+115.17	+125.17	+145.17	+165.17	+215.17	+265.17
	Q	− 76.0	535.8	591.3	596.4	601.4	606.5	611.6	616.7	627.0	637.2	662.9	688.9
	Vol.	0.02333	21.99	27.86	28.39	28.93	29.46	29.99	30.53	31.60	32.67	35.35	38.02
	φ	− .1665	1.2742	1.3949	1.4047	1.4144	1.4241	1.4324	1.4422	1.4600	1.4774	1.5182	1.5562

SUPERHEATED AMMONIA (Nos. 13 to 20)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
13	Temp.	−32.10		−22.10	−12.10	− 2.10	+ 7.90	+17.90	+27.90	+37.90	+47.90	+57.90	+67.90
	Q	−73.1	536.6	541.6	546.6	551.7	556.7	561.7	566.8	571.9	576.9	582.0	587.1
	Vol.	0.02340	20.40	20.90	21.39	21.88	22.38	22.88	23.37	23.87	24.36	24.85	25.35
	ϕ	− .1592	1.2667	1.2790	1.2907	1.3021	1.3137	1.3246	1.3355	1.3462	1.3567	1.3670	1.3773
14	Temp.	−29.55		−10.55	− 9.55	+ 0.45	+10.45	+20.45	+30.45	+40.45	+50.45	+60.45	+70.45
	Q	−70.2	537.5	542.5	547.6	552.6	557.7	562.7	567.8	572.8	577.9	582.9	588.0
	Vol.	0.02345	19.02	19.48	19.94	20.41	20.87	21.33	21.78	22.25	22.71	23.17	23.63
	ϕ	− .1523	1.2599	1.2721	1.2839	1.2952	1.3068	1.3177	1.3286	1.3392	1.3499	1.3601	1.3703
15	Temp.	−27.16		−17.16	− 7.16	+ 2.84	+12.84	+22.84	+32.84	+42.84	+52.84	+62.84	+72.84
	Q	−67.5	538.5	543.5	548.6	553.6	558.7	563.7	568.8	573.9	578.9	584.0	589.1
	Vol.	0.02351	17.83	18.28	18.70	19.13	19.55	19.98	20.41	20.85	21.28	21.72	22.15
	ϕ	− .1458	1.2537	1.2659	1.2777	1.2889	1.3005	1.3114	1.3222	1.3329	1.3436	1.3538	1.3639
16	Temp.	−24.87		−14.87	− 4.87	+ 5.13	+15.13	+25.13	+35.13	+45.13	+55.13	+65.13	+75.13
	Q	−65.0	538.7	543.7	548.8	553.8	558.9	563.9	569.0	574.1	579.1	584.2	589.3
	Vol.	0.02356	16.78	17.19	17.60	18.01	18.41	18.82	19.23	19.63	20.04	20.45	20.85
	ϕ	− .1399	1.2473	1.2594	1.2713	1.2825	1.2940	1.3049	1.3157	1.3264	1.3371	1.3473	1.3573
17	Temp.	−22.69		−12.69	− 2.69	+ 7.31	+17.31	+27.31	+37.31	+47.31	+57.31	+67.31	+77.31
	Q	−62.4	539.5	544.6	549.6	554.7	559.7	564.8	569.9	575.0	580.0	585.1	590.2
	Vol.	0.02361	15.85	16.25	16.64	17.02	17.41	17.79	18.17	18.56	18.94	19.32	19.71
	ϕ	− .1343	1.2416	1.2536	1.2656	1.2767	1.2882	1.2991	1.3099	1.3206	1.3312	1.3415	1.3515
18	Temp.	−20.61		−10.61	− 0.61	+ 9.39	+19.39	+29.39	+39.39	+49.39	+59.39	+69.39	+79.39
	Q	−60.1	540.0	545.1	550.1	555.2	560.2	565.3	570.4	575.5	580.5	585.6	590.7
	Vol.	0.02366	15.015	15.38	15.74	16.11	16.41	16.83	17.20	17.56	17.92	18.28	18.65
	ϕ	− .1289	1.2361	1.2481	1.2600	1.2712	1.2826	1.2935	1.3043	1.3150	1.3256	1.3359	1.3459
19	Temp.	−18.63		− 8.63	+ 1.37	+11.37	+21.37	+31.37	+41.37	+51.37	+61.37	+71.37	+81.37
	Q	−57.9	540.5	545.6	550.6	555.7	560.7	565.8	570.8	576.0	581.1	586.2	591.3
	Vol.	0.02371	14.30	14.64	14.99	15.34	15.67	16.01	16.36	16.70	17.05	17.38	17.72
	ϕ	− .1238	1.2311	1.2431	1.2550	1.2661	1.2775	1.2884	1.2992	1.3099	1.3204	1.3307	1.3408
20	Temp.	−16.70		− 6.70	+ 3.30	+13.30	+23.30	+33.30	+43.30	+53.30	+63.30	+73.30	+83.30
	Q	−55.7	541.0	546.1	551.1	556.2	561.2	566.4	571.5	576.60	581.7	586.8	591.9
	Vol.	0.02376	13.66	13.985	14.309	14.632	14.955	15.277	15.601	15.923	16.245	16.566	16.888
	ϕ	− .1188	1.2262	1.2382	1.2501	1.2612	1.2725	1.2834	1.2942	1.3049	1.3152	1.3256	1.3357

SUPERHEATED AMMONIA (Nos. 13 to 20). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
13	Temp.	−32.10		+77.90	+ 87.90	+ 97.90	+107.90	+117.90	+127.90	+147.90	+167.90	+217.90	+267.90
	Q	−73.1	536.6	592.2	597.3	602.3	607.4	612.5	617.6	627.9	638.1	663.8	689.8
	Vol.	0.02340	20.40	25.84	26.33	26.82	27.32	27.80	28.30	29.29	30.27	32.74	35.21
	φ	− .1592	1.2667	1.3872	1.3970	1.4067	1.4165	1.4252	1.4345	1.4522	1.4697	1.5105	1.5485
14	Temp.	−29.55		+80.45	+ 90.45	+100.45	+110.45	+120.45	+130.45	+150.45	+170.45	+220.45	+270.45
	Q	−70.2	537.5	593.1	598.2	603.3	608.4	613.5	618.6	628.7	639.1	664.8	690.9
	Vol.	0.02345	19.02	24.09	24.55	25.01	25.47	25.93	26.39	27.31	28.22	30.51	32.80
	φ	− .1523	1.2599	1.3802	1.3900	1.3998	1.4094	1.4182	1.4274	1.4451	1.4627	1.5033	1.5411
15	Temp.	−27.16		+82.84	+ 92.84	+102.84	+112.84	+122.84	+132.84	+152.84	+172.84	+222.84	+272.84
	Q	−67.5	538.5	594.2	599.3	604.3	609.4	614.5	619.6	629.9	640.2	665.9	692.0
	Vol.	0.02351	17.83	22.58	23.01	23.45	23.88	24.31	24.74	25.59	26.44	28.57	30.69
	φ	− .1458	1.2537	1.3737	1.3837	1.3934	1.4029	1.4118	1.4209	1.4387	1.4562	1.4967	1.5347
16	Temp.	−24.87		+85.13	+ 95.13	+105.13	+115.13	+125.13	+135.13	+155.13	+175.13	+225.13	+275.13
	Q	−65.0	538.7	594.4	599.5	604.6	609.7	614.8	619.9	630.2	640.4	666.2	692.3
	Vol.	0.02356	16.78	21.26	21.67	22.07	22.47	22.88	23.28	24.07	24.87	26.86	28.86
	φ	− .1399	1.2473	1.3672	1.3772	1.3868	1.3963	1.4052	1.4143	1.4321	1.4495	1.4901	1.5278
17	Temp.	−22.69		+87.31	+ 97.31	+107.31	+117.31	+127.31	+137.31	+157.31	+177.31	+227.31	+277.31
	Q	−62.4	539.5	595.3	600.4	605.5	610.6	61.57	620.8	631.1	641.3	662.1	693.3
	Vol.	0.02361	15.85	20.08	20.46	20.84	21.22	21.60	21.96	22.73	23.49	25.36	27.24
	φ	− .1343	1.2416	1.3614	1.3714	1.3809	1.3904	1.3993	1.4084	1.4261	1.4435	1.4841	1.5216
18	Temp.	−20.61		+89.39	+ 99.39	+109.39	+119.39	+129.39	+139.39	+159.39	+179.39	+229.39	+279.39
	Q	−60.1	540.0	595.8	600.9	606.1	611.3	616.3	621.4	631.7	641.9	667.7	693.9
	Vol.	0.02366	15.015	19.01	19.37	19.73	20.09	20.46	20.81	21.52	22.23	24.00	25.77
	φ	− .1289	1.2361	1.3558	1.3657	1.3751	1.3846	1.3936	1.4026	1.4203	1.4378	1.4784	1.5159
19	Temp.	−18.63		+91.37	+101.37	+111.37	+121.37	+131.37	+141.37	+161.37	+181.37	+231.37	+281.39
	Q	−57.9	540.5	596.4	601.5	606.6	611.7	616.8	621.9	632.2	642.5	668.4	694.5
	Vol.	0.02371	14.30	18.07	18.41	18.74	19.08	19.43	19.76	20.44	21.12	22.80	24.48
	φ	− .1238	1.2311	1.3506	1.3605	1.3699	1.3794	1.3883	1.3974	1.4150	1.4326	1.4731	1.5105
20	Temp.	−16.70		+93.30	+103.30	+113.30	+123.30	+133.30	+143.30	+163.30	+183.30	+233.30	+283.30
	Q	−55.7	541.0	597.0	602.1	607.2	612.3	617.4	622.5	632.8	643.1	669.0	696.1
	Vol.	0.02376	13.66	17.209	17.529	17.850	18.170	18.49	18.829	19.506	20.183	21.75	23.29
	φ	− .1188	1.2262	1.3454	1.3552	1.3647	1.3743	1.3832	1.3922	1.4099	1.4274	1.4677	1.5052

SUPERHEATED AMMONIA (Nos. 21 to 28)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
21	Temp.	−14.84		− 4.84	+ 5.16	+15.16	+25.16	+35.16	+45.16	+55.16	+65.16	+75.16	+85.16
	Q	−53.6	541.4	546.5	551.5	556.6	561.6	566.8	571.9	577.0	582.1	587.2	591.3
	Vol.	0.02381	13.025	13.335	13.644	13.955	14.275	14.573	14.882	15.191	15.499	15.807	16.114
	ϕ	− .1141	1.2217	1.2337	1.2456	1.2567	1.2679	1.2788	1.2896	1.3003	1.3106	1.3209	1.3309
22	Temp.	−13.07		− 3.07	+ 6.93	+16.93	+26.93	+36.93	+46.93	+56.93	+66.93	+76.93	+86.93
	Q	−51.6	541.7	546.8	551.8	556.9	561.9	567.1	572.2	577.3	582.4	587.5	592.6
	Vol.	0.02386	12.470	12.767	13.063	13.359	13.655	13.950	14.246	14.541	14.835	15.129	15.423
	ϕ	− .1096	1.2173	1.2293	1.2411	1.2522	1.2635	1.2743	1.2851	1.2957	1.3062	1.3163	1.3263
23	Temp.	−11.36		− 1.36	+ 8.64	+18.64	+28.64	+38.64	+48.64	+58.64	+68.64	+78.64	+88.64
	Q	−49.6	542.2	547.3	552.4	557.4	562.5	567.6	572.7	577.8	583.0	588.1	593.2
	Vol.	0.02390	11.965	12.251	12.536	12.820	13.105	13.389	13.672	13.955	14.238	14.521	14.803
	ϕ	− .1043	1.2139	1.2259	1.2377	1.2488	1.2600	1.2708	1.2816	1.2922	1.3027	1.3128	1.3228
24	Temp.	− 9.69		+ 0.31	+10.31	+20.31	+30.31	+40.31	+50.31	+60.31	+70.31	+80.31	+90.31
	Q	−47.7	542.6	547.7	552.8	557.8	562.9	568.0	573.1	578.3	583.4	588.6	593.7
	Vol.	0.02394	11.490	11.763	12.035	12.307	12.579	12.850	13.121	13.392	13.663	13.933	14.203
	ϕ	− .1011	1.2091	1.2211	1.2328	1.2440	1.2551	1.2659	1.2767	1.2873	1.2978	1.3079	1.3179
25	Temp.	− 8.08		+ 1.92	+11.92	+21.92	+31.92	+41.92	+51.92	+61.92	+71.92	+81.92	+91.92
	Q	−45.9	543.0	548.1	553.2	558.3	563.4	568.5	573.6	578.7	583.9	589.0	594.1
	Vol.	0.02399	11.065	11.327	11.589	11.85	12.11	12.372	12.632	12.893	13.153	13.412	13.672
	ϕ	− .0970	1.2053	1.2173	1.2289	1.2401	1.2513	1.2620	1.2728	1.2833	1.2938	1.3040	1.3140
26	Temp.	− 6.54		+ 3.46	+13.46	+23.46	+33.46	+43.46	+53.46	+63.46	+73.46	+83.46	+93.46
	Q	−44.2	543.3	548.4	553.5	558.6	563.7	568.8	573.9	579.0	584.2	589.3	594.4
	Vol.	0.02403	10.682	10.933	11.184	11.434	11.685	11.935	12.185	12.434	12.683	12.932	13.181
	ϕ	− .0932	1.2018	1.2138	1.2254	1.2366	1.2477	1.2584	1.2691	1.2798	1.2901	1.3003	1.3103
27	Temp.	− 5.06		+ 4.94	+14.94	+24.94	+34.94	+44.94	+54.94	+64.94	+74.94	+84.94	+94.94
	Q	−42.5	543.6	548.7	553.8	559.0	564.1	569.2	574.3	579.4	584.6	589.7	594.8
	Vol.	0.02407	10.308	10.551	10.793	11.035	11.277	11.519	11.760	12.001	12.242	12.482	12.723
	ϕ	− .0895	1.1982	1.2101	1.2217	1.2328	1.2441	1.2547	1.2654	1.2761	1.2864	1.2966	1.3066
28	Temp.	− 3.59		+ 6.41	+16.41	+26.41	+36.41	+46.41	+56.41	+66.41	+76.41	+86.41	+96.41
	Q	−40.8	543.9	549.0	554.1	559.3	564.4	569.5	574.6	579.8	584.9	590.1	595.2
	Vol.	0.02410	9.969	10.203	10.436	10.669	10.902	11.134	11.367	11.599	11.831	12.063	12.294
	ϕ	− .0859	1.1946	1.2065	1.2181	1.2292	1.2404	1.2509	1.2617	1.2724	1.2827	1.2929	1.3027

SUPERHEATED AMMONIA (Nos. 21 to 28). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
21	Temp.	−14.84		+ 95.16	+105.16	+115.16	+125.16	+135.16	+145.16	+165.16	+185.16	+235.16	+285.16
	Q	−53.6	541.4	597.4	602.5	607.7	612.8	617.9	623.0	633.3	643.6	669.5	695.7
	Vol.	0.02381	13.025	16.422	16.729	17.036	17.344	17.65	17.956	18.559	19.180	20.707	22.23
	ϕ	− .1141	1.2217	1.3408	1.3506	1.3601	1.3695	1.3785	1.3875	1.4050	1.4227	1.4629	1.5004
22	Temp.	−13.07		+ 96.93	+106.93	+116.93	+126.93	+136.93	+146.93	+166.93	+186.93	+236.93	+286.93
	Q	−51.6	541.7	597.7	602.8	608.0	613.1	618.2	623.4	633.7	644.0	669.9	696.1
	Vol.	0.02386	12.470	15.717	16.011	16.304	16.597	16.890	17.192	17.766	18.350	19.806	21.26
	ϕ	− .1096	1.2173	1.3363	1.3461	1.3554	1.3651	1.3738	1.3828	1.4003	1.4181	1.4583	1.4956
23	Temp.	−11.36		+ 98.64	+108.64	+118.64	+128.64	+138.64	+148.64	+168.64	+188.64	+238.64	+288.64
	Q	−49.6	542.2	598.3	603.4	608.6	613.7	618.8	624.0	634.2	644.6	670.5	696.7
	Vol.	0.02390	11.965	15.085	15.367	15.638	15.958	16.20	16.486	17.038	17.596	18.989	20.102
	ϕ	− .1043	1.2139	1.3328	1.3424	1.3519	1.3614	1.3702	1.3791	1.3967	1.4143	1.4544	1.4919
24	Temp.	− 9.69		+100.31	+110.31	+120.31	+130.31	+140.31	+150.31	+160.31	+190.31	+240.31	+290.31
	Q	−47.7	542.6	598.8	603.9	609.1	614.2	619.3	624.5	634.8	645.1	671.0	697.2
	Vol.	0.02394	11.490	14.473	14.743	15.012	15.281	15.55	15.816	16.347	16.877	18.20	19.52
	ϕ	− .1011	1.2091	1.3278	1.3374	1.3469	1.3564	1.3652	1.3741	1.3917	1.4091	1.4493	1.4867
25	Temp.	− 8.08		+101.92	+111.92	+121.92	+131.92	+141.92	+151.92	+171.92	+191.92	+241.92	+291.92
	Q	−45.9	543.0	599.2	604.3	609.5	614.6	619.7	624.9	635.2	645.5	671.5	697.7
	Vol.	0.02399	11.065	13.931	14.190	14.448	14.707	14.965	15.278	15.791	16.303	17.586	18.81
	ϕ	− .0970	1.2053	1.3238	1.3334	1.3429	1.3524	1.3612	1.3702	1.3877	1.4052	1.4453	1.4826
26	Temp.	− 6.54		+103.46	+113.46	+123.46	+133.46	+143.46	+153.46	+173.46	+193.46	+243.46	+293.46
	Q	−44.2	543.3	599.5	604.7	609.8	615.0	620.1	625.3	635.6	645.9	671.9	698.2
	Vol.	0.02403	10.682	13.429	13.677	13.915	14.173	14.42	14.67	15.163	15.657	16.890	18.12
	ϕ	− .0932	1.2018	1.3200	1.3298	1.3393	1.3487	1.3574	1.3665	1.3840	1.4015	1.4416	1.4788
27	Temp.	− 5.06		+104.94	+114.94	+124.94	+134.94	+144.94	+154.94	+174.94	+194.94	+244.94	+294.94
	Q	−42.5	543.6	599.9	605.1	610.2	614.4	620.5	625.7	636.0	646.3	672.3	698.6
	Vol.	0.02407	10.308	12.963	13.202	13.442	13.881	13.92	14.158	14.635	15.110	16.296	17.48
	ϕ	− .0895	1.1982	1.3162	1.3261	1.3355	1.3450	1.3535	1.3627	1.3801	1.3977	1.4377	1.4749
28	Temp.	− 3.59		+106.41	+116.41	+126.41	+136.41	+146.41	+156.41	+176.41	+196.41	+246.41	+296.41
	Q	−40.8	543.9	600.3	605.4	610.6	615.7	620.8	626.0	636.3	646.7	672.7	699.1
	Vol.	0.02410	9.969	12.526	12.757	12.988	13.219	13.45	13.680	14.141	14.600	15.747	16.89
	ϕ	− .0859	1.1946	1.3124	1.3223	1.3316	1.3411	1.3498	1.3587	1.3763	1.3938	1.4338	1.4709

SUPERHEATED AMMONIA (Nos. 30 to 44)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
30	Temp.	− 0.78		+ 9.22	+19.22	+29.22	+39.22	+49.22	+59.22	+69.22	+79.22	+89.22	+ 99.22
	Q	−37.6	544.5	549.6	554.7	559.9	565.0	570.1	575.3	580.4	585.6	590.7	595.9
	Vol.	0.02418	9.344	9.563	9.782	10.00	10.218	10.436	10.653	10.871	11.088	11.304	11.521
	ϕ	− .0789	1.1884	1.2002	1.2118	1.2229	1.2340	1.2445	1.2553	1.2659	1.2763	1.2864	1.2962
32	Temp.	+ 1.88		+11.88	+21.88	+31.88	+41.88	+51.88	+61.88	+71.88	+81.88	+91.88	+101.88
	Q	−34.6	545.1	550.2	555.3	560.5	565.6	570.7	575.9	581.1	586.2	591.4	596.6
	Vol.	0.02425	8.798	9.003	9.209	9.413	9.618	9.822	10.026	10.230	10.433	10.636	10.839
	ϕ	− .0722	1.1827	1.1945	1.2061	1.2169	1.2281	1.2387	1.2495	1.2600	1.2703	1.2805	1.2902
34	Temp.	+ 4.43		+14.43	+24.43	+34.43	+44.43	+54.43	+64.43	+74.43	+84.43	+94.43	+104.43
	Q	−31.7	545.6	550.7	555.9	561.0	566.2	571.3	576.5	581.6	586.8	591.9	597.1
	Vol.	0.02432	8.302	8.497	8.691	8.885	9.078	9.271	9.465	9.656	9.850	10.042	10.234
	ϕ	− .0659	1.1772	1.1890	1.2005	1.2113	1.2224	1.2332	1.2437	1.2543	1.2646	1.2746	1.2844
36	Temp.	+ 6.83		+16.83	+26.83	+36.83	+46.83	+56.83	+66.83	+76.83	+86.83	+96.83	+106.83
	Q	−28.9	546.2	551.4	556.4	561.7	566.8	572.0	577.2	582.4	587.5	592.7	597.9
	Vol.	0.02438	7.870	8.054	8.248	8.421	8.604	8.789	8.969	9.152	9.333	9.515	9.697
	ϕ	− .0599	1.1722	1.1840	1.1954	1.2062	1.2172	1.2281	1.2385	1.2491	1.2594	1.2693	1.2791
38	Temp.	+ 9.14		+19.14	+29.14	+39.14	+49.14	+59.14	+69.14	+79.14	+89.14	+99.14	+109.14
	Q	−26.3	546.6	551.8	556.8	562.1	567.2	572.4	576.6	582.8	587.9	593.1	598.3
	Vol.	0.02445	7.478	7.654	7.830	8.005	8.180	8.355	8.529	8.703	8.876	9.049	9.222
	ϕ	− .0543	1.1675	1.1792	1.1906	1.2015	1.2125	1.2232	1.2335	1.2442	1.2545	1.2644	1.2740
40	Temp.	+11.34		+21.34	+31.34	+41.34	+51.34	+61.34	+71.34	+81.34	+91.34	+101.34	+111.34
	Q	−23.7	547.0	552.2	557.4	562.4	567.7	572.9	578.1	583.3	588.4	593.6	598.8
	Vol.	0.02450	7.117	7.286	7.455	7.624	7.797	7.959	8.126	8.293	8.458	8.623	8.788
	ϕ	− .0490	1.1629	1.1745	1.1860	1.1968	1.2078	1.2184	1.2288	1.2394	1.2497	1.2596	1.2691
42	Temp.	+13.48		+23.48	+33.48	+43.48	+53.48	+63.48	+73.48	+83.48	+93.48	+103.48	+113.48
	Q	−21.2	547.5	552.7	557.9	562.9	568.2	573.4	578.6	583.8	589.0	594.2	599.4
	Vol.	0.02457	6.797	6.959	7.118	7.280	7.440	7.600	7.759	7.917	8.076	8.234	8.391
	ϕ	− .0438	1.1580	1.1695	1.1810	1.1918	1.2028	1.2132	1.2237	1.2343	1.2445	1.2544	1.2640
44	Temp.	+15.56		+25.56	+35.56	+45.56	+55.56	+65.56	+75.56	+85.56	+95.56	+105.56	+115.56
	Q	−18.8	547.9	553.1	558.3	563.5	568.7	573.9	579.1	584.3	589.5	594.7	599.9
	Vol.	0.02463	6.504	6.659	6.814	6.968	7.121	7.274	7.426	7.577	7.728	7.878	8.028
	ϕ	− .0388	1.1535	1.1650	1.1765	1.1871	1.1982	1.2086	1.2190	1.2295	1.2398	1.2496	1.2590

SUPERHEATED AMMONIA (Nos. 30 to 44). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
30	Temp.	− 0.78		+109.22	+119.22	+129.22	+139.22	+149.22	+159.22	+179.22	+199.22	+249.22	+299.22
	Q	−37.6	544.5	601.0	606.1	611.3	616.4	621.5	626.7	637.1	647.5	673.5	699.8
	Vol.	0.02418	9.344	11.737	11.953	12.169	12.385	12.60	12.816	13.246	13.677	14.750	15.82
	φ	− .0789	1.1884	1.3059	1.3157	1.3250	1.3346	1.3433	1.3521	1.3696	1.3872	1.4270	1.4641
32	Temp.	+ 1.88		+111.88	+121.88	+131.88	+141.88	+151.88	+161.88	+181.88	+201.88	+251.88	+301.88
	Q	−34.6	545.1	601.7	606.9	612.0	617.3	622.3	627.5	637.8	648.2	674.3	700.6
	Vol.	0.02425	8.798	11.042	11.244	11.446	11.648	11.85	12.053	12.459	12.863	13.873	14.88
	φ	− .0722	1.1827	1.2999	1.3097	1.3190	1.3285	1.3371	3.3459	1.3634	1.3809	1.4207	1.4577
34.	Temp.	+ 4.43		+114.43	+124.43	+134.43	+144.43	+154.43	+164.43	+184.43	+204.43	+254.43	+304.43
	Q	−31.7	545.6	602.3	607.5	612.6	617.8	623.0	628.2	638.5	648.9	675.0	701.4
	Vol.	0.02432	8.302	10.426	10.617	10.808	10.999	11.19	11.381	11.762	12.143	13.093	14.04
	φ	− .0659	1.1772	1.2940	1.3040	1.3131	1.3226	1.3311	1.3400	1.3574	1.3749	1.4146	1.4515
36	Temp.	+ 6.83		+116.83	+126.83	+136.83	+146.83	+156.83	+166.83	+186.83	+206.83	+256.83	+306.83
	Q	−28.9	546.2	603.1	608.2	613.4	618.5	623.7	628.9	639.3	649.7	675.8	698.2
	Vol.	0.02438	7.870	9.878	10.059	10.239	10.420	10.60	10.801	11.163	11.524	12.423	13.30
	φ	− .0599	1.1722	1.2887	1.2986	1.3077	1.3172	1.3257	1.3344	1.3520	1.3694	1.4090	1.4459
38	Temp.	+ 9.14		+119.14	+129.14	+139.14	+149.14	+159.14	+169.14	+189.14	+209.14	+259.14	+309.14
	Q	−26.3	546.6	603.5	608.7	613.8	619.0	624.2	629.4	639.8	650.2	676.4	702.8
	Vol.	0.02445	7.478	9.395	9.566	9.737	9.909	10.08	10.251	10.592	10.833	11.782	12.63
	φ	− .0543	1.1675	1.2837	1.2935	1.3025	1.3122	1.3205	1.3293	1.3468	1.3643	1.4039	1.4405
40	Temp.	+11.34		+121.34	+131.34	+141.34	+151.34	+161.34	+171.34	+191.34	+211.34	+261.34	+311.34
	Q	−23.7	547.0	604.0	609.2	614.3	619.5	624.7	629.9	640.4	650.8	677.0	703.4
	Vol.	0.02450	7.117	8.952	9.116	9.280	9.443	9.606	9.669	10.094	10.418	11.227	12.033
	φ	− .0490	1.1629	1.2788	1.2884	1.2975	1.3072	1.3156	1.3242	1.3417	1.3590	1.3987	1.4352
42	Temp.	+13.48		+123.48	+133.48	+143.48	+153.48	+163.48	+173.48	+193.48	+213.48	+263.48	+313.48
	Q	−21.2	547.5	604.6	609.8	615.0	620.2	625.4	630.6	641.0	651.4	677.7	704.1
	Vol.	0.02457	6.797	8.548	8.685	8.862	9.018	9.174	9.330	9.640	9.950	10.723	11.494
	φ	− .0438	1.1580	1.2736	1.2832	1.2923	1.3019	1.3102	1.3189	1.3363	1.3536	1.3930	1.4298
44	Temp.	+15.56		+125.56	+135.56	+145.56	+155.56	+165.56	+175.56	+195.56	+215.56	+265.56	+315.56
	Q	−18.8	547.9	605.1	610.3	615.5	620.7	625.9	631.1	641.6	652.0	678.2	704.7
	Vol.	0.02463	6.504	8.178	8.326	8.475	8.623	8.771	8.946	9.241	9.535	10.270	11.001
	φ	− .0388	1.1535	1.2688	1.2785	1.2875	1.2970	1.3063	1.3140	1.3313	1.3486	1.3880	1.4245

SUPERHEATED AMMONIA (Nos. 46 to 75)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
46	Temp.	+17.59		+27.59	+37.59	+47.59	+57.59	+67.59	+ 77.59	+ 87.59	+ 97.59	+107.59	+117.59
	Q	−16.6	548.2	553.4	558.6	563.8	569.0	574.2	579.4	584.6	589.9	595.1	600.3
	Vol.	0.02468	6.239	6.388	6.537	6.685	6.832	6.978	7.125	7.270	7.415	7.559	7.703
	ϕ	− .0341	1.1494	1.1608	1.1724	1.1829	1.1939	1.2044	1.2147	1.2252	1.2354	1.2452	1.2547
48	Temp.	+19.48		+29.48	+39.48	+49.48	+59.48	+69.48	+ 79.48	+ 89.48	+ 99.48	+109.48	+119.48
	Q	−14.4	548.6	553.8	559.0	564.3	569.5	574.7	579.9	585.1	590.3	595.5	600.7
	Vol.	0.02474	5.998	6.142	6.287	6.428	6.570	6.711	6.851	6.990	7.129	7.268	7.406
	ϕ	− .0295	1.1454	1.1567	1.1683	1.1787	1.1896	1.2002	1.2106	1.2207	1.2312	1.2409	1.2504
50	Temp.	+21.29		+31.29	+41.29	+51.29	+61.29	+71.29	+ 81.29	+ 91.29	+101.29	+111.29	+121.29
	Q	−12.2	549.0	554.2	559.5	564.7	570.0	575.2	580.4	585.6	590.8	596.0	601.2
	Vol.	0.02479	5.776	5.916	6.054	6.191	6.328	6.462	6.597	6.731	6.864	6.997	7.129
	ϕ	− .0252	1.1416	1.1528	1.1645	1.1748	1.1857	1.1963	1.2066	1.2171	1.2271	1.2368	1.2464
55	Temp.	+25.70		+35.70	+45.70	+55.70	+65.70	+75.70	+ 85.70	+ 95.70	+105.70	+115.70	+125.70
	Q	− 7.2	549.7	554.9	560.2	565.4	570.7	575.9	581.1	586.4	591.6	596.9	602.1
	Vol.	0.02492	5.284	5.410	5.535	5.659	5.783	5.905	6.028	6.149	6.270	6.391	6.510
	ϕ	− .0150	1.1326	1.1437	1.1554	1.1656	1.1765	1.1868	1.1971	1.2076	1.2176	1.2274	1.2366
60	Temp.	+29.76		+39.76	+49.76	+59.76	+69.76	+79.76	+ 89.76	+ 99.76	+109.76	+119.76	+129.76
	Q	− 2.6	550.3	555.6	560.8	566.1	571.3	576.6	581.9	587.1	592.4	597.6	602.9
	Vol.	0.02504	4.861	4.977	5.093	5.208	5.322	5.435	5.548	5.660	5.772	5.883	5.994
	ϕ	− .0053	1.1243	1.1353	1.1470	1.1572	1.1679	1.1782	1.1883	1.1988	1.2088	1.2185	1.2276
65	Temp.	+33.62		+43.62	+53.62	+63.62	+73.62	+83.62	+ 93.62	+103.62	+113.62	+123.62	+133.62
	Q	+ 1.9	551.1	556.4	561.7	566.9	572.2	577.5	582.8	588.0	593.3	598.6	603.8
	Vol.	0.02515	4.505	4.613	4.720	4.826	4.932	5.037	5.141	5.245	5.349	5.452	5.554
	ϕ	+ .0038	1.1166	1.1276	1.1390	1.1492	1.1598	1.1701	1.1802	1.1906	1.2005	1.2102	1.2194
70	Temp.	+37.22		+47.22	+57.22	+67.22	+77.22	+87.22	+ 97.22	+107.22	+117.22	+127.22	+137.22
	Q	+ 5.9	551.6	556.9	562.2	567.4	572.7	578.0	583.3	588.6	593.8	599.1	604.4
	Vol.	0.02526	4.197	4.298	4.398	4.498	4.596	4.695	4.792	4.890	4.986	5.081	5.177
	ϕ	+ .0121	1.1096	1.1205	1.1318	1.1420	1.1526	1.1628	1.1728	1.1831	1.1930	1.2026	1.2116
75	Temp.	+40.66		+50.66	+60.66	+70.66	+80.66	+90.66	+100.66	+110.66	+120.66	+130.66	+140.66
	Q	+ 9.9	552.1	557.4	562.7	568.0	573.3	578.6	583.9	589.2	594.5	599.8	605.1
	Vol.	0.02536	3.927	4.022	4.116	4.210	4.303	4.395	4.487	4.579	4.669	4.760	4.850
	ϕ	+ .0200	1.1032	1.1141	1.1252	1.1354	1.1470	1.1562	1.1661	1.1762	1.1862	1.1957	1.2045

SUPERHEATED AMMONIA (Nos. 46 to 75). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
46	Temp.	+17.59		+127.59	+137.59	+147.59	+157.59	+167.59	+177.59	+197.59	+217.59	+267.59	+317.59
	Q	−16.6	548.2	605.5	610.7	615.9	621.1	626.3	631.5	642.0	652.4	678.7	705.2
	Vol.	0.02468	6.239	7.846	7.989	8.132	8.275	8.417	8.559	8.843	9.117	9.833	10.537
	ϕ	− .0341	1.1494	1.2644	1.2742	1.2832	1.2925	1.3018	1.3094	1.3267	1.3442	1.3834	1.4197
48	Temp.	+19.48		+129.48	+139.48	+149.48	+159.48	+169.48	+179.48	+199.48	+219.48	+269.48	+319.48
	Q	−14.4	548.6	605.9	611.1	616.4	621.6	626.8	632.0	642.5	652.9	679.3	705.7
	Vol.	0.02474	5.998	7.543	7.681	7.817	7.954	8.090	8.232	8.516	8.800	9.463	10.121
	ϕ	− .0295	1.1454	1.2602	1.2698	1.2788	1.2882	1.2974	1.3052	1.3223	1.3396	1.3792	1.4152
50	Temp.	+21.29		+131.29	+141.29	+151.29	+161.29	+171.29	+181.29	+201.29	+221.29	+271.29	+321.29
	Q	−12.2	549.0	606.4	611.6	616.9	622.1	627.3	632.5	643.0	653.5	679.9	706.3
	Vol.	0.02479	5.776	7.260	7.391	7.522	7.652	7.782	7.917	8.185	8.452	9.103	9.737
	ϕ	− .0252	1.1416	1.2559	1.2656	1.2746	1.2840	1.2931	1.3009	1.3180	1.3354	1.3745	1.4108
55	Temp.	+25.70		+135.70	+145.70	+155.70	+165.70	+175.70	+185.70	+205.70	+225.70	+275.70	+325.70
	Q	− 7.2	549.7	607.3	612.6	617.8	623.1	628.3	633.5	644.0	654.5	680.9	707.5
	Vol.	0.02492	5.284	6.630	6.749	6.867	6.985	7.102	7.223	7.463	7.690	8.255	8.888
	ϕ	− .0150	1.1326	1.2461	1.2558	1.2648	1.2741	1.2823	1.2908	1.3078	1.3251	1.3641	1.4001
60	Temp.	+29.76		+139.76	+149.76	+159.76	+169.76	+179.76	+189.76	+209.76	+229.76	+279.76	+329.76
	Q	− 2.6	550.3	608.1	613.[illegible]	618.6	623.9	629.1	634.4	644.9	655.4	681.9	708.5
	Vol.	0.02504	4.861	6.104	6.213	6.323	6.431	6.540	6.652	6.874	7.095	7.647	8.196
	ϕ	− .0053	1.1243	1.2371	1.2468	1.2556	1.2648	1.2731	1.2815	1.2985	1.3158	1.3546	1.3904
65	Temp.	+33.62		+143.62	+153.62	+163.62	+173.62	+183.62	+193.62	+213.62	+233.62	+283.62	+333.62
	Q	+ 1.9	551.1	609.1	614.4	619.6	624.9	630.2	635.5	646.0	656.5	683.0	709.7
	Vol.	0.02515	4.505	5.656	5.758	5.859	5.960	6.060	6.151	6.340	6.552	7.079	7.604
	ϕ	+ .0038	1.1166	1.2286	1.2384	1.2471	1.2564	1.2644	1.2728	1.2898	1.3069	1.3456	1.3818
70	Temp.	+37.22		+147.22	+157.22	+167.22	+177.22	+187.22	+197.22	+217.22	+237.22	+287.22	+337.22
	Q	+ 5.9	551.6	609.7	615.0	620.3	625.6	630.9	636.2	646.7	657.3	683.9	710.5
	Vol.	0.02526	4.197	5.272	5.367	5.462	5.555	5.649	5.747	5.941	6.135	6.619	7.092
	ϕ	+ .0121	1.1096	1.2209	1.2306	1.2395	1.2486	1.2566	1.2648	1.2818	1.2989	1.3372	1.3731
75	Temp.	+40.66		+150.66	+160.66	+170.66	+180.66	+190.66	+200.66	+220.66	+240.66	+290.66	+340.66
	Q	+ 9.9	552.1	610.4	615.7	621.0	626.3	631.6	636.9	647.4	658.0	684.7	711.4
	Vol.	0.02536	3.927	4.939	5.028	5.117	5.205	5.293	5.384	5.565	5.746	6.197	6.648
	ϕ	+ .0200	1.1032	1.2137	1.2236	1.2323	1.2413	1.2492	1.2577	1.2744	1.2915	1.3296	1.3652

SUPERHEATED AMMONIA (Nos. 80 to 115)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
80	Temp.	+43.88		+53.88	+63.88	+73.88	+ 83.88	+ 93.88	+103.88	+113.88	+123.88	+133.88	+143.88
	Q	+13.6	552.7	558.0	563.3	568.7	574.0	579.3	584.6	589.9	595.2	600.6	605.8
	Vol.	0.02547	3.696	3.786	3.874	3.963	4.050	4.137	4.223	4.309	4.395	4.480	4.564
	φ	+ .0275	1.0972	1.1081	1.1190	1.1294	1.1408	1.1501	1.1597	1.1698	1.1797	1.1892	1.1980
85	Temp.	+47.02		+57.02	+67.02	+77.02	+ 87.02	+ 97.02	+107.02	+117.02	+127.02	+137.02	+147.02
	Q	+17.2	553.1	558.4	563.7	569.1	574.4	579.8	585.1	590.4	595.8	601.1	606.4
	Vol.	0.02556	3.485	3.572	3.656	3.740	3.823	3.906	3.988	4.069	4.150	4.230	4.310
	φ	+ .0345	1.0917	1.1025	1.1134	1.1236	1.1350	1.1440	1.1538	1.1639	1.1737	1.1832	1.1919
90	Temp.	+49.97		+59.97	+69.97	+79.97	+ 89.97	+ 99.97	+109.97	+119.97	+129.97	+139.97	+149.97
	Q	+20.7	553.5	558.9	564.2	568.6	574.9	580.3	585.6	590.9	596.3	601.6	606.9
	Vol.	0.02566	3.300	3.385	3.465	3.544	3.622	3.700	3.778	3.855	3.931	4.007	4.083
	φ	+ .0411	1.0863	1.0971	1.1079	1.1181	1.1293	1.1384	1.1482	1.1583	1.1678	1.1773	1.1861
95	Temp.	+52.83		+62.83	+72.83	+82.83	+ 92.83	+102.83	+112.83	+122.83	+132.83	+142.83	+152.83
	Q	+23.9	553.9	559.3	564.7	570.0	575.4	580.8	586.1	591.4	596.8	602.1	607.4
	Vol.	0.02575	3.134	3.211	3.287	3.363	3.438	3.512	3.586	3.660	3.733	3.806	3.878
	φ	+ .0476	1.0813	1.0920	1.1028	1.1128	1.1230	1.1332	1.1428	1.1528	1.1623	1.1718	1.1805
100	Temp.	+55.58		+65.58	+75.58	+85.58	+ 95.58	+105.58	+115.58	+125.58	+135.58	+145.58	+155.58
	Q	+27.1	554.1	559.5	564.9	570.2	575.6	581.0	586.4	591.7	597.1	602.4	607.8
	Vol.	0.02584	2.980	3.053	3.125	3.197	3.268	3.339	3.409	3.479	3.549	3.618	3.687
	φ	+ .0537	1.0767	1.0872	1.0980	1.1080	1.1194	1.1284	1.1379	1.1478	1.1573	1.1667	1.1755
105	Temp.	+58.14		+68.14	+78.14	+88.14	+ 98.14	+108.14	+118.14	+128.14	+138.14	+148.14	+158.14
	Q	+30.0	554.4	559.8	565.2	570.5	575.9	581.3	586.7	592.1	597.4	602.8	608.2
	Vol.	0.02592	2.844	2.914	2.983	3.051	3.119	3.187	3.254	3.321	3.388	3.454	3.520
	φ	+ .0596	1.0722	1.0826	1.0934	1.1034	1.1146	1.1236	1.1331	1.1430	1.1524	1.1618	1.1704
110	Temp.	+60.67		+70.67	+80.67	+90.67	+100.67	+110.67	+120.67	+130.67	+140.67	+150.67	+160.67
	Q	+33.0	554.7	560.1	565.5	570.9	576.3	581.7	587.1	592.5	597.9	603.3	608.7
	Vol.	0.02601	2.716	2.783	2.849	2.915	2.980	3.045	3.110	3.174	3.238	3.302	3.366
	φ	+ .0651	1.0677	1.0780	1.0887	1.0987	1.1099	1.1188	1.1283	1.1382	1.1475	1.1569	1.1655
115	Temp.	+63.19		+73.19	+83.19	+93.19	+103.19	+113.19	+123.19	+133.19	+143.19	+153.19	+163.19
	Q	+35.8	554.9	560.3	565.7	571.2	576.6	582.0	587.4	592.8	598.2	603.6	609.0
	Vol.	0.02609	2.602	2.666	2.730	2.793	2.856	2.918	2.980	3.042	3.103	3.164	3.225
	φ	+ .0706	1.0632	1.0734	1.0841	1.0942	1.1052	1.1142	1.1235	1.1333	1.1426	1.1520	1.1604

SUPERHEATED AMMONIA (Nos. 80 to 115). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
80	Temp.	+43.88		+153.88	+163.88	+173.88	+183.88	+193.88	+203.88	+223.88	+243.88	+293.88	+343.88
	Q	+13.6	552.7	611.1	616.4	621.8	627.1	632.4	637.7	648.3	658.9	685.6	712.3
	Vol.	0.02547	3.696	4.648	4.732	4.816	4.899	4.982	5.067	5.237	5.406	5.828	6.25
	φ	+ .0275	1.0972	1.2072	1.2170	1.2255	1.2344	1.2422	1.2508	1.2674	1.2844	1.3224	1.3580
85	Temp.	+47.02		+157.02	+167.02	+177.02	+187.02	+197.02	+207.02	+227.02	+247.02	+297.02	+347.02
	Q	+17.2	553.5	611.7	617.0	622.4	627.7	633.0	638.3	648.9	659.4	686.3	713.1
	Vol.	0.02556	3.485	4.389	4.467	4.545	4.623	4.701	4.781	4.942	5.103	5.501	5.900
	φ	+ .0345	1.0917	1.2012	1.2107	1.2195	1.2282	1.2362	1.2446	1.2611	1.2779	1.3159	1.3514
90	Temp.	+49.97		+159.97	+169.97	+179.97	+189.97	+199.97	+209.97	+229.97	+249.97	+299.97	+349.97
	Q	20.7	553.5	612.2	617.5	622.9	628.2	633.5	638.8	648.5	660.2	686.9	713.8
	Vol.	+ 0.02566	3.300	4.159	4.234	4.309	4.383	4.458	4.533	4.692	4.842	5.214	5.586
	φ	.0411	1.0863	1.1051	1.2048	1.2133	1.2222	1.2299	1.2383	1.2548	1.2715	1.3095	1.3447
95	Temp.	+52.83		+162.83	+172.83	+182.83	+192.83	+202.83	+212.83	+232.83	+252.83	+302.83	+352.83
	Q	+23.9	553.9	612.7	618.1	623.4	628.8	634.1	639.4	650.1	660.8	687.6	714.5
	Vol.	0.02575	3.134	3.950	4.022	4.094	4.166	4.237	4.309	4.452	4.594	4.950	5.305
	φ	+ .0476	1.0813	1.1895	1.1991	1.2076	1.2164	1.2243	1.2328	1.2489	2.2655	1.3033	1.3385
100	Temp.	+55.58		+165.58	+175.58	+185.58	+195.58	+205.58	+215.58	+235.58	+255.58	+305.58	+355.58
	Q	+27.1	554.1	613.1	618.5	623.8	629.2	634.5	639.9	650.6	661.3	688.1	715.0
	Vol.	0.02584	2.980	3.755	3.823	3.891	3.949	4.027	4.095	4.230	4.365	4.701	5.037
	φ	+ .0537	1.0767	1.1842	1.1939	1.2025	1.2112	1.2190	1.2272	1.2435	1.2602	1.2977	1.3327
105	Temp.	+58.14		+168.14	+178.14	+188.14	+198.14	+208.14	+218.14	+238.14	+258.14	+308.14	+358.14
	Q	+30.0	554.4	613.5	618.9	624.2	629.6	634.9	640.3	651.0	661.8	688.6	715.7
	Vol.	0.02592	2.844	3.585	3.651	3.716	3.781	3.846	3.911	4.040	4.169	4.490	4.810
	φ	+ .0596	1.0722	1.1792	1.1888	1.1972	1.2060	1.2137	1.2222	1.2382	1.2547	1.2922	1.3272
110	Temp.	+60.67		+170.67	+180.67	+190.67	+200.67	+210.67	+220.67	+240.67	+260.67	+310.67	+360.67
	Q	+33.0	554.7	614.0	619.4	624.7	630.1	635.4	640.8	651.5	662.3	689.2	716.3
	Vol.	0.02601	2.716	3.429	3.492	3.555	3.618	3.680	3.723	3.849	3.975	4.277	4.604
	φ	+ .0651	1.0677	1.1742	1.1837	1.1922	1.2008	1.2087	1.2172	1.2329	1.2495	1.2867	1.3217
115	Temp.	+63.19		+173.19	+183.19	+193.19	+203.19	+213.19	+223.19	+243.19	+263.19	+313.19	+363.19
	Q	+35.8	554.9	614.4	619.7	625.1	630.4	635.8	641.2	652.0	662.8	689.7	716.8
	Vol.	0.02609	2.602	3.286	3.346	3.407	3.467	3.520	3.586	3.705	3.823	4.117	4.411
	φ	+ .0706	1.0632	1.1692	1.1787	1.1872	1.1957	1.2034	1.2117	1.2277	1.2442	1.2812	1.3161

SUPERHEATED AMMONIA (Nos. 120 to 150)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
120	Temp.	+65.49		+75.49	+85.49	+ 95.49	+105.49	+115.49	+125.49	+135.49	+145.49	+155.49	+165.49
	Q	+38.5	555.1	560.5	566.0	571.4	576.9	582.3	587.7	593.1	598.6	604.0	609.4
	Vol.	0.02618	2.497	2.559	2.620	2.680	2.741	2.801	2.860	2.919	2.979	3.037	3.096
	ϕ	+ .0758	1.0592	1.0693	1.0800	1.0902	1.1011	1.1099	1.1192	1.1290	1.1382	1.1476	1.1560
125	Temp.	+67.81		+77.81	+87.81	+ 97.81	+107.81	+117.81	+127.81	+137.81	+147.81	+157.81	+167.81
	Q	+41.1	555.2	560.7	566.1	571.6	577.0	582.5	587.9	593.3	598.8	604.2	609.6
	Vol.	0.02626	2.400	2.459	2.528	2.577	2.635	2.693	2.750	2.808	2.865	2.921	2.978
	ϕ	+ .0808	1.0555	1.0656	1.0762	1.0863	1.0973	1.1058	1.1154	1.1250	1.1341	1.1435	1.1518
130	Temp.	+70.1		+80.1	+90.1	+100.1	+110.1	+120.1	+130.1	+140.1	+150.1	+160.1	+170.1
	Q	+43.9	555.3	560.8	566.3	571.7	577.2	582.7	588.1	593.6	599.0	604.5	609.9
	Vol.	0.02634	2.309	2.366	2.423	2.480	2.536	2.592	2.648	2.704	2.759	2.814	2.868
	ϕ	+ .0858	1.0517	1.0617	1.0723	1.0822	1.0932	1.1018	1.1112	1.1209	1.1301	1.1392	1.1477
135	Temp.	+72.2		+82.2	+92.2	+102.2	+112.2	+122.2	+132.2	+142.2	+152.2	+162.2	+172.2
	Q	+46.3	555.5	561.0	566.5	572.0	577.5	583.0	588.4	593.9	599.3	604.8	610.2
	Vol.	0.02642	2.227	2.282	2.338	2.392	2.337	2.501	2.554	2.608	2.661	2.714	2.767
	ϕ	+ .0905	1.0480	1.0580	1.0685	1.0784	1.0883	1.0980	1.1072	1.1169	1.1260	1.1352	1.1435
140	Temp.	+74.2		+84.2	+94.2	+104.2	+114.2	+124.2	+134.2	+144.2	+154.2	+164.2	+174.2
	Q	+48.7	555.6	561.1	566.6	572.1	577.6	583.1	588.6	594.1	599.5	605.0	610.5
	Vol.	0.02649	2.149	2.203	2.256	2.309	2.362	2.415	2.467	2.519	2.571	2.624	2.675
	ϕ	+ .0950	1.0444	1.0544	1.0648	1.0746	1.0855	1.0944	1.1034	1.1131	1.1222	1.1313	1.1395
145	Temp.	+76.3		+86.3	+96.3	+106.3	+116.3	+126.3	+136.3	+146.3	+156.3	+166.3	+176.3
	Q	+51.1	555.7	561.2	566.7	572.3	577.8	583.3	588.8	594.3	599.8	605.3	610.8
	Vol.	0.02657	2.076	2.128	2.180	2.232	2.284	2.335	2.386	2.436	2.486	2.536	2.586
	ϕ	+ .0995	1.0412	1.0512	1.0616	1.0713	1.0822	1.0910	1.1000	1.1096	1.1187	1.1278	1.1362
150	Temp.	+78.3		+88.3	+98.3	+108.3	+118.3	+128.3	+138.3	+148.3	+158.3	+168.3	+178.3
	Q	+53.4	555.9	561.4	567.0	572.5	578.1	583.6	589.1	594.6	600.1	605.6	611.1
	Vol.	0.02664	2.008	2.059	2.109	2.160	2.210	2.259	2.308	2.357	2.406	2.454	2.502
	ϕ	+ .1039	1.0381	1.0481	1.0584	1.0681	1.0781	1.0876	1.0968	1.1063	1.1153	1.1244	1.1328

SUPERHEATED AMMONIA (Nos. 120 to 150). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
120	Temp.	+65.49		+175.49	+185.49	+195.49	+205.49	+215.49	+225.49	+245.49	+265.49	+315.49	+365.49
	Q	+38.5	555.1	614.8	620.1	625.5	630.8	636.2	641.6	652.5	663.3	690.2	717.4
	Vol.	0.02618	2.497	3.154	3.213	3.271	3.328	3.385	3.434	3.549	3.663	3.946	4.235
	ϕ	+ .0758	1.0592	1.1647	1.1747	1.1826	1.1912	1.1990	1.2072	1.2230	2.2392	1.2762	1.3111
125	Temp.	+67.81		+177.81	+187.81	+197.81	+207.81	+217.81	+227.81	+247.81	+267.81	+317.81	+367.81
	Q	+41.1	555.2	615.0	620.4	625.7	631.1	636.5	641.9	652.8	663.6	690.6	717.8
	Vol.	.02626	2.400	3.034	3.090	3.146	3.202	3.257	3.312	3.422	3.531	3.803	4.074
	ϕ	+ .0808	1.0555	1.1605	1.1700	1.1784	1.1868	1.1945	1.2030	1.2185	1.2347	1.2717	1.3064
130	Temp.	+70.1		+180.1	+190.1	+200.1	+210.1	+220.1	+230.1	+250.1	+270.1	+320.1	+370.1
	Q	+43.9	555.3	615.3	620.7	626.0	631.4	636.8	642.2	653.1	663.9	691.0	718.2
	Vol.	0.02634	2.309	2.923	2.977	3.031	3.084	3.138	3.191	3.297	3.402	3.663	3.923
	ϕ	+ .0858	1.0517	1.1563	1.1657	1.1739	1.1825	1.1902	1.1985	1.2142	1.2302	1.2669	1.3017
135	Temp.	+72.2		+182.2	+192.2	+202.2	+212.2	+222.2	+232.2	+252.2	+272.2	+322.2	+372.2
	Q	+46.3	555.5	615.6	621.0	626.4	631.8	637.2	642.6	653.5	664.4	691.5	718.8
	Vol.	0.02642	2.227	2.819	2.872	2.924	2.975	3.027	3.078	3.180	3.282	3.536	3.787
	ϕ	+ .0905	1.0480	1.1522	1.1615	1.1699	1.1782	1.1860	1.1942	1.2100	1.2260	1.2625	1.2970
140	Temp.	+74.2		+184.2	+194.2	+204.2	+214.2	+224.2	+234.2	+254.2	+274.2	+324.2	+374.2
	Q	+48.7	555.6	615.9	621.3	626.7	632.1	637.5	642.9	653.8	664.7	691.9	719.3
	Vol.	0.02649	2.149	2.726	2.776	2.827	2.877	2.927	2.975	3.075	3.174	3.418	3.660
	ϕ	+ .0950	1.0444	1.1483	1.1575	1.1658	1.1742	1.1819	1.1902	1.2056	1.2216	1.2582	1.2924
145	Temp.	+76.3		+186.3	+196.3	+206.3	+216.3	+226.3	+236.3	+256.3	+276.3	+326.3	+376.3
	Q	+51.1	555.7	616.2	621.6	627.0	632.4	637.8	643.3	654.2	665.1	692.4	719.7
	Vol.	0.02657	2.076	2.636	2.685	2.734	2.783	2.832	2.876	2.974	3.069	3.304	3.538
	ϕ	+ .0995	1.0412	1.1447	1.1540	1.1622	1.1705	1.1783	1.1864	1.2020	1.2177	1.2542	1.2884
150	Temp.	+78.3		+188.3	+198.3	+208.3	+218.3	+228.3	+238.3	+258.3	+278.3	+328.3	+378.3
	Q	+53.4	555.9	616.5	622.0	627.4	632.9	638.3	643.8	654.7	665.6	692.9	720.2
	Vol.	0.02664	2.008	2.550	2.598	2.646	2.693	2.740	2.788	2.881	2.973	3.201	3.425
	ϕ	+ .1039	1.0381	1.1414	1.1504	1.1586	1.1669	1.1749	1.1829	1.1984	1.2141	1.2504	1.2846

SUPERHEATED AMMONIA (Nos. 155 to 200)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
155	Temp.	+80.2		+ 90.2	+100.2	+110.2	+120.2	+130.2	+140.2	+150.2	+160.2	+170.2	+180.2
	Q	+55.7	556.0	561.6	567.1	572.7	578.2	583.8	589.3	594.8	600.4	605.9	611.4
	Vol.	0.02671	1.944	1.993	2.043	2.091	2.139	2.188	2.235	2.283	2.330	2.377	2.423
	ϕ	+ .1082	1.0348	1.0448	1.0550	1.0648	1.0748	1.0841	1.0933	1.1028	1.1119	1.1208	1.1291
160	Temp.	+82.1		+ 92.1	+102.1	+112.1	+122.1	+132.1	+142.1	+152.1	+162.1	+172.1	+182.1
	Q	+57.8	556.1	561.7	567.3	572.8	578.4	584.0	589.5	595.1	600.6	606.2	611.7
	Vol.	0.02678	1.885	1.983	1.981	2.028	2.076	2.122	2.169	2.215	2.261	2.307	2.353
	ϕ	+ .1122	1.0318	1.0418	1.0520	1.0618	1.0717	1.0810	1.0901	1.0998	1.1088	1.1177	1.1259
165	Temp.	+84.0		+ 94.0	+104.0	+114.0	+124.0	+134.0	+144.0	+154.0	+164.0	+174.0	+184.0
	Q	+60.1	556.3	561.9	567.5	573.1	578.7	584.3	589.8	595.4	600.9	606.5	612.0
	Vol.	0.02685	1.828	1.875	1.921	1.968	2.013	2.059	2.104	2.149	2.193	2.238	2.282
	ϕ	+ .1162	1.0288	1.0388	1.0489	1.0588	1.0687	1.0778	1.0870	1.0966	1.1056	1.1145	1.1228
170	Temp.	+85.8		+ 95.8	+105.8	+115.8	+125.8	+135.8	+145.8	+155.8	+165.8	+175.8	+185.8
	Q	+62.2	556.4	562.0	567.6	573.3	578.9	584.5	590.1	595.6	601.2	606.7	612.3
	Vol.	0.02692	1.776	1.822	1.867	1.912	1.957	2.002	2.046	2.090	2.133	2.176	2.219
	ϕ	+ .1201	1.0259	1.0359	1.0460	1.0559	1.0657	1.0749	1.0840	1.0936	1.1025	1.1114	1.1198
180	Temp.	+89.3		+ 99.3	+109.3	+119.3	+129.3	+139.3	+149.3	+159.3	+169.3	+179.3	+189.3
	Q	+66.3	556.5	562.2	567.8	573.5	579.1	584.8	590.4	596.0	601.5	607.1	612.7
	Vol.	0.02705	1.677	1.721	1.764	1.807	1.850	1.892	1.935	1.976	2.018	2.059	2.100
	ϕ	+ .1277	1.0204	1.0304	1.0405	1.0504	1.0601	1.0694	1.0784	1.0880	1.0968	1.1057	1.1141
190	Temp.	+92.7		+102.7	+112.7	+122.7	+132.7	+142.7	+152.7	+162.7	+172.7	+182.7	+192.7
	Q	+70.3	556.5	562.2	567.9	573.6	579.3	585.0	590.6	596.2	601.9	607.5	613.1
	Vol.	0.02718	1.589	1.631	1.673	1.714	1.755	1.795	1.836	1.876	1.915	1.954	1.993
	ϕ	+ .1348	1.0149	1.0249	1.0350	1.0449	1.0544	1.0639	1.0729	1.0824	1.0910	1.0999	1.1084
200	Temp.	+95.9		+105.9	+115.9	+125.9	+135.9	+145.9	+155.9	+165.9	+175.9	+185.9	+195.9
	Q	+74.1	556.6	562.3	568.1	573.8	579.6	585.3	590.9	596.6	602.2	607.9	613.5
	Vol.	0.02732	1.510	1.550	1.590	1.630	1.666	1.708	1.747	1.785	1.822	1.860	1.897
	ϕ	+ .1414	1.0097	1.0197	1.0299	1.0397	1.0492	1.0587	1.0677	1.0772	1.0858	1.0947	1.1032

SUPERHEATED AMMONIA (Nos. 155 to 200). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
155	Temp.	+80.2		+190.2	+200.2	+210.2	+220.2	+230.2	+240.2	+260.2	+280.2	+330.2	+380.2
	Q	+55.7	556.0	616.8	622.3	627.7	633.2	638.6	644.1	655.0	665.9	693.3	720.7
	Vol.	0.02671	1.944	2.470	2.516	2.562	2.608	2.656	2.700	2.791	2.881	3.102	3.322
	φ	+ .1082	1.0348	1.1378	1.1468	1.1548	1.1632	1.1711	1.1792	1.1946	1.2103	1.2466	1.2805
160	Temp.	+82.1		+192.1	+202.1	+212.1	+222.1	+232.1	+242.1	+262.1	+282.1	+332.1	+382.1
	Q	+57.8	556.1	617.1	622.1	628.0	633.5	638.9	644.4	655.3	666.3	693.7	721.2
	Vol.	0.02678	1.885	2.398	2.443	2.488	2.533	2.577	2.621	2.708	2.795	3.011	3.224
	φ	+ .1122	1.0318	1.1346	1.1436	1.1517	1.1598	1.1678	1.1758	1.1913	1.2068	1.2429	1.2768
165	Temp.	+84.0		+194.0	+204.0	+214.0	+224.0	+234.0	+244.0	+264.0	+284.0	+334.0	+384.0
	Q	+60.1	556.3	617.5	623.0	628.4	633.9	639.4	644.9	655.8	666.8	694.2	721.7
	Vol.	0.02685	1.828	2.326	2.369	2.413	2.456	2.500	2.543	2.627	2.711	2.920	3.126
	φ	+ .1162	1.0288	1.1313	1.1401	1.1485	1.1566	1.1645	1.1725	1.1878	1.2033	1.2393	1.2733
170	Temp.	+85.8		+195.8	+205.8	+215.8	+225.8	+235.8	+245.8	+265.8	+285.8	+335.8	+385.8
	Q	+62.2	556.4	617.8	623.3	628.7	634.2	639.7	645.2	656.2	667.2	694.7	722.1
	Vol.	0.02692	1.776	2.262	2.305	2.347	2.389	2.431	2.472	2.555	2.637	2.839	3.040
	φ	+ .1201	1.0259	1.1281	1.1370	1.1452	1.1534	1.1612	1.1692	1.1846	1.1999	1.2359	1.2699
180	Temp.	+89.3		+199.3	+209.3	+219.3	+229.3	+239.3	+249.3	+269.3	+289.3	+339.3	+389.3
	Q	+66.3	556.5	618.2	623.7	629.3	634.8	640.3	645.8	656.9	667.9	695.4	723.0
	Vol.	0.02705	1.677	2.141	2.181	2.221	2.261	2.301	2.341	2.419	2.497	2.690	2.881
	φ	+ .1277	1.0204	1.1224	1.1313	1.1393	1.1474	1.1554	1.1634	1.1784	1.1937	1.2296	1.2634
190	Temp.	+92.7		+202.7	+212.7	+222.7	+232.7	+242.7	+252.7	+272.7	+292.7	+342.7	+392.7
	Q	+70.3	556.5	618.6	624.2	629.7	635.3	640.8	646.3	657.4	668.4	696.1	723.7
	Vol.	0.02718	1.589	2.032	2.071	2.109	2.147	2.185	2.223	2.298	2.372	2.556	2.738
	φ	+ .1348	1.0149	1.1169	1.1254	1.1335	1.1417	1.1497	1.1574	1.1727	1.1878	1.2234	1.2569
200	Temp.	+95.9		+205.9	+215.9	+225.9	+235.9	+245.9	+255.9	+275.9	+295.9	+345.9	+395.9
	Q	+74.1	556.6	619.1	624.7	630.3	635.9	641.5	647.0	658.1	669.1	696.9	724.6
	Vol.	0.02732	1.510	1.934	1.971	2.007	2.043	2.079	2.115	2.186	2.257	2.433	2.602
	φ	+ .1414	1.0097	1.1117	1.1202	1.1282	1.1363	1.1442	1.1522	1.1672	1.1822	1.2177	1.2512

SUPERHEATED AMMONIA (Nos. 210 to 270)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
210	Temp.	+99.0		+109.0	+119.0	+129.0	+139.0	+149.0	+159.0	+169.0	+179.0	+189.0	+199.0
	Q	+77.7	556.5	562.3	568.1	573.8	579.6	585.4	591.1	596.8	602.4	608.1	613.8
	Vol.	0.02744	1.438	1.477	1.515	1.553	1.591	1.628	1.665	1.702	1.738	1.774	1.810
	ϕ	+ .1479	1.0048	1.0148	1.0252	1.0348	1.0443	1.0538	1.0629	1.0723	1.0810	1.0898	1.0984
220	Temp.	+102.0		+112.0	+122.0	+132.0	+142.0	+152.0	+162.0	+172.0	+182.0	+192.0	+202.0
	Q	+81.2	556.5	562.3	568.2	574.0	579.9	585.7	591.4	597.1	602.7	608.4	614.1
	Vol.	0.02757	1.371	1.409	1.446	1.483	1.519	1.555	1.591	1.625	1.661	1.696	1.730
	ϕ	+ .1541	1.0003	1.0103	1.0208	1.0303	1.0400	1.0493	1.0586	1.0678	1.0766	1.0854	1.0940
230	Temp.	+104.9		+114.9	+124.9	+134.9	+144.9	+154.9	+164.9	+174.9	+184.9	+194.9	+204.9
	Q	+84.6	556.4	562.3	568.1	574.0	579.8	585.7	591.4	597.2	602.9	608.7	614.4
	Vol.	0.02769	1.312	1.348	1.384	1.420	1.455	1.490	1.524	1.558	1.592	1.625	1.658
	ϕ	+ .1602	0.9959	1.0061	1.0165	1.0259	1.0357	1.0449	1.0544	1.0636	1.0724	1.0812	1.0899
240	Temp.	+107.7		+117.7	+127.7	+137.7	+147.7	+157.7	+167.7	+177.7	+187.7	+197.7	+207.7
	Q	+87.9	556.3	562.2	568.1	574.0	579.9	585.8	591.6	597.4	603.1	608.9	614.7
	Vol.	0.02782	1.256	1.291	1.326	1.361	1.395	1.428	1.462	1.494	1.527	1.559	1.591
	ϕ	+ .1660	0.9916	1.0019	1.0123	1.0217	1.0316	1.0408	1.0504	1.0596	1.0686	1.0773	1.0861
250	Temp.	+110.4		+120.4	+130.4	+140.4	+150.4	+160.4	+170.4	+180.4	+190.4	+200.4	+210.4
	Q	+91.1	556.0	561.9	567.9	572.9	579.8	585.7	591.5	597.3	603.1	608.9	614.7
	Vol.	0.02794	1.204	1.239	1.273	1.306	1.339	1.372	1.404	1.436	1.468	1.499	1.530
	ϕ	+ .1717	0.9874	0.9978	1.0084	1.0176	1.0274	1.0369	1.0466	1.0556	1.0649	1.0736	1.0824
260	Temp.	+113.1		+123.1	+133.1	+143.1	+153.1	+163.1	+173.1	+183.1	+193.1	+203.1	+213.1
	Q	+94.2	555.9	561.9	567.9	573.9	579.9	585.9	591.7	597.5	603.4	669.2	615.0
	Vol.	0.02806	1.158	1.192	1.225	1.257	1.289	1.321	1.298	1.383	1.413	1.444	1.473
	ϕ	+ .1771	0.9834	0.9939	1.0044	1.0139	1.0237	1.0334	1.0396	1.0522	1.0614	1.0702	1.0789
270	Temp.	+115.6		+125.6	+135.6	+145.6	+155.6	+165.6	+175.6	+185.6	+195.6	+205.6	+215.6
	Q	+97.2	555.7	561.7	567.8	573.8	579.9	585.9	591.7	597.6	603.4	609.3	615.1
	Vol.	0.02817	1.113	1.145	1.176	1.207	1.238	1.268	1.298	1.327	1.356	1.385	1.413
	ϕ	+ .1824	0.9795	0.9901	1.0005	1.0104	1.0201	1.0296	1.0396	1.0487	1.0580	1.0667	1.0760

SUPERHEATED AMMONIA (Nos. 210 to 270). — *Continued*

No.		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
210	Temp.	+99.0		+209.0	+219.0	+229.0	+239.0	+249.0	+259.0	+279.0	+299.0	+349.0	+399.0
	Q	+77 7	556.5	619.4	625.0	630.6	636.2	641.8	647.4	658.5	669.6	697.4	725.2
	Vol.	0.02744	1.438	1.845	1.877	1.915	1.960	1.984	2.019	2.087	2.155	2.322	2.488
	φ	+ .1479	1.0048	1.1069	1.1153	1.1233	1.1314	1.1393	1.1473	1.1623	1.1773	1.2123	1.2458
220	Temp.	+102.0		+212.0	+222.0	+232.0	+242.0	+252.0	+262.0	+282.0	+302.0	+352.0	+402.0
	Q	+81.2	556.5	619.7	625.4	631.0	636.7	642.3	647.9	659.0	670.2	698.0	725.9
	Vol.	0.02757	1.371	1.764	1.798	1.832	1.865	1.898	1.931	1.997	2.061	2.221	2.38
	φ	+ .1541	1,0003	1.0026	1.1110	1.1188	1.1270	1.1350	1.1428	1.1579	1.1728	1.2075	1.2411
230	Temp.	+104.9		+214.9	+224.9	+234.9	+244.9	+254.9	+264.9	+284.9	+304.9	+354.9	+404.9
	Q	+84.6	556.4	620.1	625.7	631.4	637.0	642.7	648.3	659.4	670.6	698.5	726.6
	Vol.	0.02769	1.312	1.690	1.723	1.755	1.787	1.818	1.852	1.915	1.977	2.131	2.283
	φ	+ .1602	0.9959	1.0987	1.1068	1.1147	1.1229	1.1309	1.1384	1.1537	1.1682	1.2029	1.2364
240	Temp.	+107.7		+217.7	+227.7	+237.7	+247.7	+257.7	+267.7	+287.7	+307.7	+357.7	+407.7
	Q	+87.9	556.3	620.4	626.1	631.7	637.4	643.1	648.7	659.9	671.1	699.1	727.2
	Vol.	0.02782	1.256	1.623	1.654	1.685	1.716	1.746	1.777	1.838	1.898	2.046	2.193
	φ	+ .1660	0.9916	1.0948	1.1029	1.1106	1.1189	1.1268	1.1345	1.1496	1.1641	1.1988	1.2321
250	Temp.	+110.4		+220.4	+230.4	+240.4	+250.4	+260.4	+270.4	+290.4	+310.4	+360.4	+410.4
	Q	+91.1	556.0	620.4	626.1	631.9	637.6	643.3	648.9	660.1	671.3	699.4	727.7
	Vol.	0.02794	1.204	1.560	1.591	1.621	1.651	1.680	1.710	1.768	1.826	1.969	2.110
	φ	+ .1717	0.9874	1.0914	1.0994	1.1071	1.1152	1.1233	1.1307	1.1462	1.1604	1.1948	1.2281
260	Temp.	+113.1		+223.1	+233.1	+243.1	+253.1	+263.1	+273.1	+293.1	+313.1	+363.1	+413.1
	Q	+94.2	555.9	620.7	626.5	632.2	638.0	643.7	649.3	660.6	671.8	699.9	728.3
	Vol.	0.02806	1.158	1.503	1.532	1.561	1.590	1.618	1.647	1.704	1.760	1.898	2.034
	φ	+ .1771	0.9834	1.0879	1.0959	1.1037	1.1118	1.1200	1.1274	1.1427	1.1529	1.1923	1.2244
270	Temp.	+115.6		+225.6	+235.6	+245.6	+255.6	+265.6	+275.6	+295.6	+315.6	+365.6	+415.6
	Q	+97.2	555.7	620.9	626.7	632.4	638.2	644.0	649.6	660.9	672.2	700.4	728.9
	Vol.	0.02817	1.113	1.441	1.469	1.496	1.531	1.560	1.601	1.654	1.706	1.835	1.196
	φ	+ .1824	0.9795	1.0848	1.0930	1.1005	1.1087	1.1169	1.1243	1.1396	1.1537	1.1880	1.2210

SUPERHEATED AMMONIA (Nos. 280 to 400)

		Liquid	Vapor	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
280	Temp.	+118.1		+128.1	+138.1	+148.1	+158.1	+168.1	+178.1	+188.1	+198.1	+208.1	+218.1
	Q	+100.2	555.5	561.6	567.7	573.7	579.8	585.9	591.8	597.7	603.5	609.4	615.3
	Vol.	0.02828	1.072	1.104	1.135	1.166	1.196	1.226	1.256	1.285	1.314	1.342	1.370
	ϕ	+ .1876	0.9757	0.9866	0.9969	1.0067	1.0167	1.0262	1.0363	1.0457	1.0550	1.0637	1.0729
300	Temp.	+122.9		+132.9	+142.9	+152.9	+162.9	+172.9	+182.9	+192.9	+202.9	+212.9	+222.9
	Q	+105.9	555.0	561.2	567.4	573.5	579.7	585.9	591.8	597.8	603.7	609.7	615.6
	Vol.	0.02851	0.998	1.028	1.058	1.088	1.117	1.145	1.173	1.201	1.229	1.256	1.282
	ϕ	+ .1976	.9686	0.9796	0.9901	0.9998	1.0104	1.0204	1.0306	1.0409	1.0495	1.0581	1.0676
320	Temp.	+127.4		+137.4	+147.4	+157.4	+167.4	+177.4	+187.4	+197.4	+207.4	+217.4	+227.4
	Q	+111.3	554.5	560.8	567.0	573.3	578.5	585.8	591.8	597.8	603.8	609.8	615.8
	Vol.	0.02873	0.932	0.961	0.990	1.018	1.045	1.072	1.099	1.126	1.152	1.177	1.202
	ϕ	+ .2069	.9614	.9726	.9834	0.9934	1.0040	1.0143	1.0247	1.0342	1.0439	1.0527	1.0633
340	Temp.	+131.8		+141.8	+151.8	+161.8	+171.8	+181.8	+191.8	+201.8	+211.8	+221.8	+231.8
	Q	+116.7	554.1	560.5	566.8	562.2	579.5	585.9	592.0	598.0	604.1	610.1	616.2
	Vol.	0.02894	0.876	0.904	0.931	0.958	0.984	1.010	1.036	1.062	1.086	1.110	1.135
	ϕ	+ .2160	.9550	.9665	.9774	.9879	.9985	1.0090	1.0198	1.0292	1.0394	1.0483	1.0582
360	Temp.	+135.9		+145.9	+155.9	+165.9	+175.9	+185.9	+195.9	+205.9	+215.9	+225.9	+235.9
	Q	+121.6	553.4	559.9	566.3	571.7	579.2	585.7	591.8	598.0	604.1	610.3	616.4
	Vol.	0.02910	0.824	0.851	0.877	0.902	0.928	0.953	0.977	1.001	1.025	1.048	1.071
	Q	+ .2245	.9489	.9609	.9719	.9827	.9934	1.0041	1.0151	1.0249	1.0354	1.0445	1.0545
380	Temp.	+139.8		+149.8	+159.8	+169.8	+179.8	+189.8	+199.8	+209.8	+219.8	+229.8	+239.8
	Q	+126.5	552.8	559.4	565.9	571.5	579.0	585.6	591.8	598.0	604.2	610.4	616.6
	Vol.	0.02938	0.777	0.803	0.828	0.853	0.877	0.901	0.925	0.948	0.971	0.994	1.016
	ϕ	+ .2326	.9432	.9552	0.9664	.9780	.9890	1.0000	1.0110	1.0212	1.0318	1.0414	1.0514
400	Temp.	+143.7		+153.7	+163.7	+173.7	+183.7	+193.7	+203.7	+213.7	+223.7	+233.7	+243.7
	Q	+131.1	552.0	558.6	565.2	571.8	578.4	585.3	591.6	597.9	604.1	610.4	616.7
	Vol.	0.02958	0.736	0.761	0.785	0.809	0.833	0.856	0.879	0.901	0.923	0.945	0.966
	ϕ	+ .2404	.9376	.9501	0.9616	.9733	.9846	.9961	1.0071	1.0189	1.0284	1.0386	1.0488

SUPERHEATED AMMONIA (Nos. 280 to 400). — *Continued*

		Liquid	Vapor	110°	120°	130°	140°	150°	160°	180°	200°	250°	300°
280	Temp.	+118.1		+228.1	+238.1	+248.1	+258.1	+268.1	+278.1	+298.1	+318.1	+368.1	+418.1
	Q	+100.2	555.5	621.1	626.9	632.7	638.5	644.3	650.0	661.3	672.6	700.8	729.4
	Vol.	0.02828	1.072	1.398	1.426	1.453	1.479	1.506	1.532	1.585	1.636	1.762	1.896
	φ	+ .1876	0.9757	1.0819	1.0900	1.0977	1.1059	1.1140	1.1214	1.1369	1.1508	1.1841	1.2177
300	Temp.	+122.9		+232.9	+242.9	+252.9	+262.9	+272.9	+282.9	+302.9	+322.9	+372.9	+422.9
	Q	+105.9	555.0	621.4	627.3	633.1	639.0	644.8	650.5	661.9	673.3	701.6	730.4
	Vol.	0.02851	0.998	1.309	1.335	1.361	1.386	1.410	1.437	1.488	1.536	1.657	1.777
	φ	+ .1976	.9686	1.0768	1.0851	1.0926	1.1009	1.1089	1.1165	1.1319	1.1461	1.1801	1.2126
320	Temp.	+127.4		+237.4	+247.4	+257.4	+267.4	+277.4	+287.4	+307.4	+327.4	+377.4	+427.4
	Q	+111.3	554.5	621.7	627.6	633.6	639.5	645.4	651.1	662.6	674.1	702.4	731.4
	Vol.	0.02873	0.932	1.227	1.252	1.276	1.300	1.324	1.348	1.395	1.442	1.557	1.671
	φ	+ .2069	.9614	1.0719	1.0802	1.0881	1.0963	1.1044	1.1118	1.1284	1.1417	1.1754	1.2074
340	Temp.	+131.8		+241.8	+251.8	+261.8	+271.8	+281.8	+291.8	+311.8	+331.8	+381.8	+431.8
	Q	+116.7	554.1	622.2	628.1	634.1	640.0	646.0	651.8	663.4	675.0	703.3	732.5
	Vol.	0.02894	0.876	1.168	1.181	1.205	1.227	1.250	1.273	1.317	1.360	1.467	1.579
	φ	+ .2160	.9550	1.0680	1.0764	1.0844	1.0926	1.1008	1.1084	1.1240	1.1385	1.1719	1.2038
360	Temp.	+135.9		+245.9	+255.9	+265.9	+275.9	+285.9	+295.9	+315.9	+335.9	+385.9	+435.9
	Q	+121.6	553.4	622.4	628.4	634.4	640.4	646.4	652.2	663.9	675.5	703.9	733.2
	Vol.	0.02910	0.824	1.094	1.116	1.139	1.160	1.182	1.204	1.248	1.291	1.395	1.496
	φ	+ .2245	.9489	1.0642	1.0729	1.0812	1.0896	1.0979	1.1057	1.1214	1.1359	1.1693	1.2008
380	Temp.	+139.8		+249.8	+259.8	+269.8	+279.8	+289.8	+299.8	+319.8	+339.8	+389.8	+439.8
	Q	+126.5	552.8	622.6	628.7	634.7	640.8	646.8	652.7	664.4	676.2	704.5	734.3
	Vol.	0.02938	0.777	1.037	1.059	1.080	1.101	1.122	1.143	1.184	1.225	1.325	1.422
	φ	+ .2326	.9432	1.0612	1.0702	1.0790	1.0874	1.0957	1.1037	1.1195	1.1342	1.1676	1.1987
400	Temp.	+143.7		+253.7	+263.7	+273.7	+283.7	+293.7	+303.7	+323.7	+343.7	+393.7	+443.7
	Q	+131.1	552.0	622.8	628.9	634.9	641.0	647.1	653.0	664.9	676.7	705.1	735.1
	Vol.	0.02958	0.736	0.987	1.008	1.029	1.049	1.069	1.102	1.141	1.179	1.259	1.355
	φ	+ .2404	.9376	1.0586	1.0676	1.0771	1.0858	1.0944	1.1026	1.1181	1.1328	1.1666	1.1971